1272142

Response Action Sampling and Analysis Plan
Libby Asbestos Superfund Site
Libby, Montana

Revision 3

April 2013

Contract No. W9128F-11-D-0023
Task Order No. 0003

Prepared for:

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region 8

Prepared by:

U.S. Army Corps of Engineers
Omaha District
Offutt AFB, Nebraska 68113

and

CDM Federal Programs Corporation
555 17th Street, Suite 1100
Denver, Colorado 80202

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Contract No. W9128F-11-D-0023
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Approved by: _____ Date: 4/8/13
Thomas E. Cook, CHMM, PMP
CDM Smith Project Manager

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Approved by: _____ Date: _____
Mary Darling, PMP
USACE Project Manager

Approved by: _____ Date: 4/9/13
Elizabeth Fagen
EPA Region VIII Remedial Project Manager

Approved by: _____ Date: 4/9/13
Michael Cirian, P.E.
EPA Region VIII Onsite Remedial Project Manager

Approved by: _____ Date: 4/11/13
Rebecca Thomas
EPA Region VIII Libby Asbestos Project Team Leader

Approved by: No comment - _____ Date: 2013
Linda Himmelbauer
EPA Region VIII Quality Assurance Manager

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Document Revision Log

Revision No.	Date	Description
0	11/2003	---
1	04/2008	▪ Removed SAP from RAWP to be stand-alone document ▪ Made editorial changes, corrected typographical errors ▪ Updated confirmation soil sample collection method from 5-point to 30-point composites ▪ At least one composite confirmation soil sample collected at maximum of 625 square feet changed to 2,500 square feet ▪ Update references
2	06/2011	▪ Made editorial changes, corrected typographical errors ▪ Added visible vermiculite point inspection procedure and SOP ▪ Added DQOs for water and water sampling procedures ▪ Updated DQOs for visible vermiculite in and adjacent to soil excavation areas ▪ Updated approach to confirmation soil sample collection to include composite points from different use areas regardless of excavation depth achieved ▪ Updated references
3	04/2013	▪ Made editorial changes, corrected typographical errors ▪ Updated distribution list ▪ Added section for project/task organization ▪ Added project organizational chart ▪ Added confirmation soil sampling protocols for municipal and residential alleyways, driveways, and parking areas ▪ Added DQOs for bulk material, and procedures for bulk material visual inspection, and sample collection and analysis ▪ Updated data validation and usability section ▪ Updated references

Distribution List

Copies of this completed and signed sampling and analysis plan/quality assurance project plan (SAP/QAPP) should be distributed to:

U.S. Environmental Protection Agency, Region VIII
1595 Wynkoop Street
Denver, Colorado 80202-1129

- Rebecca Thomas, Thomas.Rebecca@epa.gov (electronic copy)
- Elizabeth Fagen, Fagen.Elizabeth@epa.gov (electronic copy)
- Don Goodrich, Goodrich.Donald@epa.gov (electronic copy)
- Jeff Mosal, Mosal.Jeffrey@epa.gov (electronic copy)

U.S. Army Corps of Engineers
Rapid Response Program Office
Offutt AFB, Nebraska 68113

- Larry Woscyna, Lawrence.J.Woscyna@usace.army.mil (electronic copy)
- Mary Darling, Mary.N.Darling@usace.army.mil (electronic copy)
- Mark Buss, Mark.E.Buss@usace.army.mil (electronic copy)
- Jeff Hubbard, Jeffrey.W.Hubbard@usace.army.mil (electronic copy)
- Jeremy Ayala, Jeremy.A.Ayala@usace.army.mil (electronic copy)
- Brian Broekemeier, Brian.J.Broekemeier@usace.army.mil (electronic copy)

EPA Information Center – Libby
108 East 9th Street
Libby, Montana 59923

- Mike Cirian, Cirian.Mike@epa.gov (1 hard copy, electronic copy)
- EPA Information Center Library, c/o Linda Newstrom (1 hard copy)

Montana Department of Environmental Quality
1100 North Last Chance Gulch
Helena, Montana 59601

- Carolyn Rutland, CRutland@mt.gov (electronic copy)
- John Podolinsky, JPodolinsky@mt.gov (electronic copy)

TechLaw, Inc.
ESAT, Region VIII
16194 West 45th Drive
Golden, Colorado 80403

- Doug Kent, Kent.Doug@epa.gov (electronic copy)
- Janelle Lohman, Lohman.Janelle@epamail.epa.gov (electronic copy)

CDM Smith – Libby Field Office
60 Port Boulevard, Suite 201
Libby, Montana 59923

- Thomas Cook, cookTE@cdmsmith.com (electronic copy)
- Scott Felton, feltonSD@cdmsmith.com (electronic copy)
- Damon Repine, repinedl@cdmsmith.com (20 hard copies, electronic copy)
- Terry Crowell, crowellTL@cdmsmith.com (electronic copy)

PRI-ER – Libby Field Office
60 Port Boulevard, Trailer #1
Libby, Montana 59923

- Gary Heller, g.heller@erllc.com (electronic copy)

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Acronyms and Abbreviations

A&E	architect and engineering contractor
AHERA	Asbestos Hazard Emergency Response Act
APP	accident prevention plan
AS	analytical sensitivity
bgs	below ground surface
BNSF	Burlington Northern Santa Fe
CAPP	comprehensive accident prevention plan
CAR	corrective action request
cc	cubic centimeters
CDM Smith	CDM Federal Programs Corporation
COC	chain-of-custody
CFR	Code of Federal Regulations
CSS	contaminant screening study
CUA	common-use area
DQOs	data quality objectives
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ERT	Environmental Response Team
ESAT	Environmental Services Assistance Team
f/cc	fibers per cubic centimeter
FPM	field planning meeting
FSDS	field sample data sheet
FTL	field team leader
GPI	general property investigation
HEPA	high-efficiency particulate air
IDW	investigation-derived waste
L	liters
LA	Libby amphibole asbestos
L/min	liters per minute
MCE	mixed cellulose ester
MDEQ	Montana Department of Environmental Quality
MFL	million fibers per liter
mg/cc	milligrams per cubic centimeter
ml	milliliters
mm	millimeter
ND	nondetect
NFG	National Functional Guidelines
NPE	negative-pressure enclosure
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
OU	operable unit
PCC	property closeout checklist
PCM	phase contrast microscopy
PCME	phase contrast microscopy equivalent
PI	point inspection
PDI	pre-design inspection
PLM	polarized light microscopy
PPE	personal protective equipment

PRI-ER	Project Resources, Inc.-Environmental Restoration Joint Venture
QA	quality assurance
QAPP	quality assurance project plan
QAR	quality assurance report
QATS	quality assurance technical support
QC	quality control
RA SAP	response action sampling and analysis plan
RAWP	response action work plan
ROM	record of modification
RPM	remedial project manager
s/cc	structures per cubic centimeter
SAP	sampling and analysis plan
SOP	standard operating procedure
STEL	short-term exposure limit
SUA	specific-use area
TEM	transmission electron microscopy
TQA	third-party quality assurance
TWA	time-weighted average
USACE	U.S. Army Corps of Engineers
VAE	visual area estimation
VV	visible vermiculite
W.R. Grace	W.R. Grace and Company
Zonolite	Universal Zonolite Insulation Company
µm	micrometer

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Section 1
Introduction

This document serves as the response action sampling and analysis plan (RA SAP) for the ongoing cleanup efforts being conducted by the U.S. Environmental Protection Agency (EPA) Region 8 at the Libby Asbestos Superfund Site. The U.S. Army Corps of Engineers (USACE) is serving as the contracting authority for the EPA under an Interagency Agreement for response actions currently being conducted in Libby. The USACE's architect and engineering contractor (A&E), CDM Federal Programs Corporation (CDM Smith), is providing third-party quality assurance (TQA) and other support services to the USACE, including the sampling activities outlined in this SAP. The details of the response action work (i.e., removal activities) at the Libby site is outlined in the Response Action Work Plan (RAWP) (Project Resources, Inc.-Environmental Restoration Joint Venture [PRI-ER] 2013). This RA SAP is intended to be used in conduction with and in support of the RAWP.

This RA SAP contains all the elements required for a quality assurance project plan (QAPP), including project management, data generation and acquisition, assessment and oversight, and data validation and usability. This RA SAP was developed in basic accordance with EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5 (EPA 2001), and the Guidance on Systematic Planning Using the Data Quality Objectives (DQOs) Process, EPA QA/G4 (EPA 2006).

The purpose of this RA SAP is to describe the sampling objectives, locations, measurement methods, and DQOs for residential, commercial, municipal, and industrial response actions at the Libby Asbestos Site. The RA SAP is organized as follows:

Section 1 - Introduction

Section 2 – Site Background

Section 3 – Data Quality Objectives

Section 4 – Sampling Program

Section 5 – Laboratory Operations

Section 6 – Assessment and Oversight

Section 7 – Data Review and Verification

Section 8 – References

1.1 Objectives

This section defines the objectives of the response action sampling program and the intended use of data.

As determined by previous investigations conducted at the Libby Asbestos Site, Libby amphibole asbestos (LA) is present in multiple environmental media in Libby including: indoor air, outdoor ambient air, indoor dust, vermiculite insulation, vermiculite containing building materials, and soils.

As a result, residents of Libby may be exposed to LA, and these exposures may pose a risk of cancer and/or non-cancer adverse health effects.

Since 2001, the EPA has been performing response actions to remove LA-contaminated media (i.e., soil, insulation, interior dust, building material) at residential, commercial, municipal, and industrial properties. The primary objective of the sampling program described in this RA SAP is to collect data of sufficient quality and representativeness to ensure LA-contaminated media is removed to meet current EPA cleanup criteria and goals, as stated in the Libby Asbestos Site, Residential/Commercial Cleanup Action Level and Clearance Criteria Technical Memorandum (EPA 2003) and Amendment A (EPA 2011). Additional objectives are discussed in Section 3.0, Data Quality Objectives.

1.2 Project/Task Organization

Figure 1-1 presents an organizational chart that shows lines of authority and reporting responsibilities for this project. The following sections summarize the entities and individuals that will be responsible for providing project management, SAP development, field sampling support, on-site field coordination, analytical support, data management, and quality assurance for this project.

1.2.1 Project Management

The EPA is the lead regulatory agency for Superfund activities within the Libby Asbestos Site. The EPA Libby Asbestos Project Team Leader is Rebecca Thomas. The EPA Remedial Project Manager (RPM) for these sampling efforts is Elizabeth Fagen. The EPA Onsite RPM is Michael Cirian.

The USACE Omaha District provides project management, environmental engineering, and remediation support to EPA at the site. The USACE Program Manager is Mary Darling. The USACE Construction Control Representatives are Jeremy Ayala, Brian Broekemeier, Jeff Hubbard, and Mark Buss.

CDM Smith is a contractor to the USACE. The CDM Smith project manager is Thomas Cook. Mr. Cook is responsible for the overall management and coordination of the investigation. He will be responsible for maintaining the official, approved SAP and documenting and distributing changes.

The Montana Department of Environmental Quality (MDEQ) is the support regulatory agency for Superfund activities at the site. The MDEQ Project Manager is Carolyn Rutland. The EPA will consult with MDEQ as provided for by the Comprehensive Environmental Response, Compensation, and Liability Act, the National Contingency Plan, and applicable guidance in conducting Superfund activities.

1.2.2 Technical Support

1.2.2.1 SAP Development

This SAP was developed by CDM Smith at the direction of, and with oversight by, the EPA. This SAP contains all required QAPP elements and has been developed in general accordance with the *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5* (EPA 2001) and the *Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G4* (EPA 2006).

Copies of the RA SAP will be distributed by the CDM Smith Project Manager (or their designate), either in hard copy or in electronic format, as indicated on the document distribution list. The CDM Smith Project Manager (or their designate) will distribute updated copies each time a SAP revision occurs.

1.2.2.2 Field Activities

CDM Smith will be responsible for implementation of RA SAP activities. Key CDM Smith personnel that will be involved in this sampling program are identified below and in Figure 1-1:

- Thomas Cook, Site Manager/Project Manager
- Scott Felton, Assistant Site Manager
- Damon Repine, Construction Manager
- Tracy Dodge, Lead Sample Coordinator
- Scott Miller, Field Data Manager
- Terry Crowell, Quality Assurance Manager
- Dominic Pisciotta, Health and Safety Manager

1.2.2.3 Asbestos Analysis

All samples collected under the RA SAP requiring asbestos analysis will be sent to laboratories selected and approved by the EPA to support the site. The EPA Environmental Services Assistance Team (ESAT) is responsible for procuring all analytical laboratory services and providing direction to the analytical laboratories. Don Goodrich (EPA Region 8) is responsible for managing the ESAT laboratory support contract for asbestos. The ESAT Team Manager at TechLaw, Inc. is Mark McDaniel. He is also the designated laboratory coordinator for the Libby project that is responsible for directing the analytical laboratories, prioritizing analysis needs, and managing laboratory capacity.

1.2.2.4 Data Management

All data generated under the RA SAP will be managed and maintained in EPA's project data repositories – Response Manager and Scribe – as required by EPA's Libby Data Management Plan (EPA 2012). The EPA Environmental Response Team (ERT) is responsible for the administration of all Scribe data management aspects of this project. Joseph Schafer is responsible for overseeing the ERT data management support contract. ERT is responsible for the development and management of Scribe and the project-specific data reporting requirements for the Libby project.

ESAT (Mark McDaniel, Team Manager) is responsible for the administration of all Response Manager data management aspects of this project. ESAT is also responsible for uploading new analytical results to the analytical Scribe project database. The ESAT data manager for the Libby project is Janelle Lohman (TechLaw, Inc.).

The CDM Smith data manager (Scott Miller) is responsible for overseeing the upload of sample information to the field Scribe project database, as well as Response Manager inputs. Mr. Miller is also responsible for maintenance of the Property Operations Tracking System (POTS) database that is integrated with Response Manager and supports USACE response action tracking needs.

Because of the quantity and complexity of the data collected at the site, the EPA has designated a Libby Data Manager to manage and oversee the various data support contractors. The EPA Region 8 Data Manager for the Libby project is Jeffrey Mosal.

1.2.2.5 Quality Assurance Management

There is no individual designated as the EPA Quality Assurance Manager for the Libby project. Rather, the Region 8 quality assurance (QA) program has delegated authority to the EPA RPMs. This means that the EPA RPMs have the ability to review and approve governing investigation documents developed by site contractors. Thus, it is the responsibility of the EPA RPM for this sampling effort (Elizabeth Fagen), who is independent of the entities planning and obtaining the data, to ensure that this SAP has been prepared in accordance with the EPA QA guidelines and requirements. The EPA RPM is also responsible for managing and overseeing all aspects of the quality assurance/quality control (QA/QC) program for this sampling effort. In this regard, the RPM is supported by the EPA Quality Assurance Technical Support (QATS) contractor, CB&I Federal Services (CB&I). The QATS contractor, will evaluate and monitor laboratory QA/QC and is responsible for performing annual audits of each analytical laboratory. CB&I's Quality Assurance Manager for this project is Michael Lenkauskas.

CDM Smith's QA Director, Jo Nell Mullins, implements the CDM Smith QA program. She is independent of project technical staff and reports directly to the president of CDM Smith on QA matters. The QA director has the authority to objectively review projects and identify problems, and the authority to use corporate resources, as necessary, to resolve any quality-related problems. CDM Smith's QA Coordinator for this project, Terry Crowell, reports to Ms. Mullins on QA matters. Under Ms. Mullin's oversight, Ms. Crowell is responsible for monitoring and evaluating field QA/QC, providing oversight of field sampling and data collection activities, and coordinating field QA activities, including identifying qualified, independent staff to conduct assessments of field activities (see Section 6).

1.3 Project Schedule

Based on data collected during EPA's site-wide contaminant screening study (CSS), approximately 1,600 properties require a response action as a result of LA contamination. These response actions could include interior removal, exterior removal, exterior demolition, or any combination of these response actions. The number of properties requiring a response action may increase depending on ongoing risk assessment findings or the development of improved analytical technologies. Periodic changes in the Libby Asbestos Site boundary and ongoing changes in individual property boundaries (e.g., through changes in land ownership, redefined county tax parcels), will also influence this number. Depending on project funding, contracting, and yearly project goals, it is anticipated that response actions will continue in Libby through 2015. Most remaining properties that require response actions have exterior contamination. Therefore, future annual removal schedules will be set, in part, based on seasonal project and weather considerations.

Section 2
Site Background

This section describes site location and history.

2.1 Site Location

The Libby Asbestos Site is located in northwest Montana within in the boundaries of Lincoln County, Montana (Figure 2-1). The site includes homes, businesses, and other properties, which may have become contaminated with asbestos fibers as a result of the vermiculite mining and processing conducted in and around the City of Libby.

The Libby Asbestos Site has been subdivided into eight operable units (OUs) to facilitate a phased approach to cleanup (Figure 2-2):

- OU1. The former export plant is defined geographically by the property boundary of the parcel of land that included the former export plant and nearby impacted areas.
- OU2. OU2 includes areas impacted by contamination released from the former screening plant. These areas include the former screening plant, the adjacent Flyway property, the Highway 37 right-of-way adjacent to the former screening plant and Rainy Creek Road, and privately-owned property.
- OU3. The mine OU includes the former vermiculite mine and the geographic area (including ponds) surrounding the former vermiculite mine that has been impacted by releases from the mine, including Rainy Creek and the Kootenai River. Rainy Creek Road is also included in OU3.
- OU4. OU4 is defined as residential, commercial, industrial (not associated with former W.R. Grace and Company [W.R. Grace] operations), and public properties, including schools and parks in and around the City of Libby, or those that have received material from the mine.
- OU5. OU5 is defined geographically by the parcel of land that included the former Stimson Lumber Company. OU5 is bounded by the high bank of Libby Creek to the east, the Kootenai River to the north, and residential/commercial/industrial property within OU4 to the south and west. This OU is approximately 400 acres in size and is currently occupied by various vacant structures/buildings as well as multiple operating businesses (lumber processing, log storage, excavation contractor, etc.). Within the OU5 boundary is the Libby Groundwater Superfund Site, which is not associated with the Libby Asbestos Site.
- OU6. Owned and operated by the Burlington Northern Santa Fe Railroad (BNSF), OU6 is defined geographically by the BNSF property boundaries from the eastern boundary of OU4 to the western boundary of OU7 and extent of contamination associated with the rail yard.
- OU7. Approximately 20 miles west of downtown Libby, the Troy OU includes all residential, commercial, and public properties in and around the town of Troy, Montana.
- OU8. OU8 is comprised of the United States and Montana State Highway rights-of-way within the OU4 and OU7 boundaries.

2.2 Site History

Vermiculite was discovered 7 miles northeast of Libby, Montana in 1881 by gold miners. In the early 1920s, Edward Alley began initial mining operations on the vermiculite ore body located approximately 7 miles northeast of Libby. Full-scale operations began later that decade under the name of the Universal Zonolite Insulation Company (Zonolite). This ore body contains a solid solution series of amphibole asbestos fibers with compositions including tremolite, actinolite, richterite, and winchite (herein referred to as LA) as defined by B.E. Leake et al. (1997). Unlike chrysotile asbestos, LA has never been used commercially on a wide scale. During the mine's operating life, while vermiculite was used in a variety of products (including insulation and construction materials, as a carrier for fertilizer and other agricultural chemicals, and as a soil conditioner), LA was considered a byproduct of little or no value.

The vermiculite ore was mined using standard strip mining techniques and conventional mining equipment. The ore was then processed in an onsite dry mill to remove waste rock and overburden material. Once processed, the ore was transported from the mine to the former screening plant, where the ore was sorted into five size ranges. After the sorting process, the material was shipped to various locations across the United States, for either direct inclusion in products or for "expansion" prior to use in products. Expansion (also known as "exfoliation" or "popping") was accomplished by heating the ore, usually in a dry kiln, to approximately 2,000 degrees Fahrenheit. This process explosively vaporizes the water contained within the phyllosilicate structure causing the vermiculite to expand by a factor of 10 to 15. This produces the vermiculite material most commonly sold as a soil amendment for gardens and greenhouses.

In Libby, operations handling this material occurred at four main locations: the mine and mill located on Rainy Creek Road on top of Zonolite Mountain; the former screening plant and railroad loading station located at the intersection of Highway 37 and Rainy Creek Road and directly across the Kootenai River, respectively; the former expansion/export plant (the former export plant) located immediately west of

Highway 37 where it crosses the Kootenai River; and at the former expansion plant located at the end of Lincoln Road, near 5th Street. The Lincoln Road Expansion Plant went offline sometime in the early 1950s.

In 1963, W.R. Grace purchased Zonolite and continued vermiculite mining operations in a similar fashion. In 1975, a wet milling process was added that operated in tandem with the dry mill until the dry mill was taken offline in 1985. The wet milling process was added to reduce dust generation of the milling process. Expansion operations at the former export plant ceased in Libby sometime prior to 1981, although this area was still used to bag and export milled ore until mining operations were stopped in 1990. Before the mine closed in 1990, Libby produced about 80 percent of the world's supply of vermiculite.

Since 1999, EPA Region 8 has been conducting sampling and cleanup activities to address highly contaminated areas in the Libby Valley. EPA mobilization was initiated in response to media articles, which detailed extensive asbestos-related health problems in the Libby population. While at first the situation was thought to be limited to those with direct or indirect occupational exposures, it soon became clear that there were multiple exposure pathways and many persons with no link to mining-related activities were affected.

2.3 Occurrence of LA

Typically, the LA contamination found in the Libby Valley comes from one or some combination of "primary" sources: vermiculite mining wastes, vermiculite ores, vermiculite processing wastes, bulk residuals from vermiculite processing, "LA-containing rocks," or LA-containing vermiculite attic insulation. Asbestos from these primary sources has been found in interior building dust samples and local soils, which in turn act as secondary sources. To date, EPA's goal has been to find and identify areas with elevated levels of LA (the primary sources) and to remove them. The EPA has conducted removal of contaminated soil at the former export plant location, the former screening plant and adjacent properties, and residential properties with LA source materials present. Removal actions have also been performed at four schools in Libby and 1 school in Troy.

Cleanup work in Libby is ongoing and includes the removal of LA-containing media that include: vermiculite insulation, soil, dust, and building materials from residential, commercial, municipal, and industrial properties. The vermiculite insulation encountered in structures is typically found in attics and exterior walls where it is used for insulation. In some cases, vermiculite insulation is found in interior and exterior walls due to sifting from the attic. The LA-contaminated soil encountered is generally due to vermiculite used as a soil amendment in flowerbeds and gardens, leveling of low spots, and backfilling of utilities. LA-contaminated dust occurs inside structures due to vermiculite insulation leaking into the living spaces from the attic or walls, and LA tracked inside from the outdoor source locations discussed above. LA-contaminated building materials is generally found as an additive in concrete, log cabin chinking, and brick or block mortar.

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Section 3

Data Quality Objectives and Criteria

The DQO process, based on scientific methods, is a series of planning steps that are designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended purpose. The DQOs presented in this section were developed in accordance with EPA guidance (EPA 2006).

The DQO process specifies project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified. The DQO process consists of seven steps; output from each step influences the choices that will be made later in the process. These steps include:

1. State the Problem
2. Identify the Decision
3. Identify the Inputs to the Decision
4. Define the Boundaries of the Study
5. Develop Decision Rules
6. Specify Tolerable Limits on Decision Errors
7. Optimize the Design for Obtaining Data

3.1 Data Quality Objectives

3.1.1 Step 1 – State the Problem

The purpose of this step is to describe the problem to be studied so that the focus of the investigation will be unambiguous.

Previous investigations such as the Phase 1 Investigation and CSS were designed to determine if LA source materials were present at a property. If LA source materials were present at a property, follow up inspections, including the pre-design inspections (PDI) (CDM Federal Programs Corporation [CDM Smith] 2003) (2003 through 2009) and general property investigations (GPIs) (CDM Smith 2010) (2010 to present), were conducted to determine the nature and extent of the contamination. Information and data collected during the historic PDIs and current GPIs are used to develop site-specific removal action work plans that accompany the RAWP.

During removal activities (e.g., excavation of contaminated soil), the potential for LA fibers to migrate offsite increases. Likewise, during these activities, the potential for LA exposure to workers is also increased. Therefore, it is important to monitor ambient air, engineering controls, and worker exposure. This is accomplished through a systematic response action air sampling program. In addition, confirmation and/or clearance samples will be collected to determine if the response actions meet project-specific goals. Therefore, the overall response action sampling program must address:

- Worker exposure to nuisance dust and LA
- The need to characterize and remove, if necessary, vermiculite- or LA-containing bulk materials
- Effectiveness of equipment-use practices and engineering controls during removal activities
- Achievement of cleanup goals following removal activities

This RA SAP describes the sampling and inspection procedures that will be used to collect data of sufficient quality and representativeness to evaluate each of these items.

3.1.2 Step 2 – Identify the Decision

This step identifies what questions the investigation will attempt to resolve and what actions may result. The principal study questions and possible alternative actions are summarized in Table 3-1.

Table 3-1. Principal Study Questions and Possible Alternative Actions

Response Item Evaluated	Principal Study Question	Alternative Actions
Worker exposure to nuisance dust and LA	Are fibers detected in the workers' breathing zone above worker safety limits?	▪ Evaluate and re-train employees on work practices that reduce dust emissions ▪ Take no action
Effectiveness of equipment-use practices and engineering controls during removal activities	Are LA structures in ambient air migrating beyond the exclusion zone boundary during contaminated soil removal activities?	▪ Evaluate engineering controls and work practices ▪ Take no action
	Are LA structures detected in stored water used for response actions (e.g., trucks, tanks, etc.)?	▪ Inspect storage equipment, flush with clean water ▪ Take no action
	Are LA structures detected in ambient or exhaust air of equipment utilized by the removal contractor?	▪ Inspect equipment HEPA filters (if equipped), replace as necessary ▪ Perform thorough wet-wiping of sampled area (e.g., decontamination trailer clean room); re-train personnel on good housekeeping practices ▪ Take no action
	Are chlorine residuals detected in potable water storage equipment?	▪ Stop use, inspect equipment, and add chlorine or dilute with clean water ▪ Take no action
Presence of vermiculite or LA in bulk building materials	Is vermiculite visible in bulk building materials?	▪ Assess location and physical condition of media; EPA and USACE to determine response action ▪ Take no action
	Is LA detected in bulk building materials?	▪ Assess location and physical condition of media; EPA and USACE to determine response action ▪ Take no action

Table 3-1. Principal Study Questions and Possible Alternative Actions (Continued)

Response Item Evaluated	Principal Study Question	Alternative Actions
Achievement of the cleanup goals following removal activities	Are LA structures detected in the air within an NPE where vermiculite insulation was removed?	▪ Re-clean and re-encapsulate NPE ▪ Take no action
	Are LA structures detected in the air within an NPE where LA-contaminated dust was removed?	▪ Re-clean NPE ▪ Take no action
	Is LA detected in the soil surface of the excavated area?	▪ Excavate additional soils ▪ Take no action
	Is vermiculite visible in the soil surface of the excavated area?	▪ Excavate additional soils ▪ Take no action
	Is vermiculite visible in the sidewalls of the excavated area?	▪ Excavate additional soils ▪ Take no action
	Is vermiculite visible in surface soils adjacent to the excavation boundary or newly identified property areas?	▪ Excavate additional soils ▪ Take no action

LA – Libby amphibole asbestos
HEPA – high-efficiency particulate air
NPE – negative-pressure enclosure

3.1.3 Step 3 – Identify the Inputs to the Decision

The purpose of this step is to identify the information and measurements that need to be obtained to resolve the decision statements. The information needed to resolve the principal study questions are summarized in Table 3-2.

This RA SAP is designed only for cleanups for which primary LA characterization at a property (e.g., soil concentration, indoor dust levels, etc.) has been performed through another sampling and analysis plan (SAP) (e.g., GPI SAP).

Table 3-2. Summary of Inputs to Resolve Study Questions and Use of Information Acquired from Inputs

Principal Study Question	Input to Resolve Question	Use of Input to Resolve Question
Are fibers detected in the workers' breathing zone above worker safety limits?	Personal Air Samples	Personal air samples will be collected on the removal contractor workers during removal activities performing specific tasks (e.g., equipment operator, laborer, bulk removal, etc.). The personal air samples results will be used to monitor removal contractor work practices, determine if respiratory protection is adequate for the task being conducted, and ensure compliance with OSHA regulatory standards.
Are LA structures in ambient air migrating beyond the exclusion zone boundary during contaminated soil removal activities?	Perimeter Air Samples	For each property undergoing exterior response actions extending greater than 4 hours, stationary air samples will be collected from the perimeter of the exclusion zone downwind of soil removal activities. The perimeter air sample results will be used to determine if the removal contractor is employing adequate engineering controls and work practices during removal activities to minimize LA migration outside the exclusion zone.
Are LA structures detected in stored water used for response actions (e.g., trucks, tanks, etc.)?	Water Samples	For all stored water used by the removal contractor during response actions, water samples will be collected from a discharge outlet (e.g., spigot). The results of the water sample will be used to determine if LA is present in the stored water.

Table 3-2. Summary of Inputs to Resolve Study Questions and Use of Information Acquired from Inputs (Continued)

Principal Study Question	Input to Resolve Question	Use of Input to Resolve Question
Are LA structures detected in ambient or exhaust air of equipment utilized by the removal contractor?	Equipment Air Monitoring Samples	For properties undergoing response actions, periodic stationary air samples will be collected from the exhaust air of equipment (e.g., industrial vacuums, negative air machines, etc.) used by the removal contractor (if applicable). Additionally, stationary air samples will be collected from the clean room of the decontamination trailer (if applicable). The stationary air sample results will be used to determine if the removal contractor is maintaining equipment properly and employing good housekeeping practices for their equipment.
Are chlorine residuals detected in potable water storage equipment?	Water Samples	For all potable water storage equipment used by the removal contractor during response actions, water samples will be collected from a discharge outlet (e.g., spigot). Water sample results be used to determine if a sufficient amount of chlorine is present to limit bacterial growth and meet potable water quality standards as described in OSHA Standard 1910.141(b)(1)(i).
Are LA structures detected in the air within an NPE where vermiculite insulation was removed?	Attic Space Clearance Air Samples	For each property undergoing vermiculite insulation removal, stationary clearance air samples will be collected from within the NPE where the vermiculite insulation was removed. The results of the clearance air samples will be used to determine if LA contamination was removed to project-specific clearance criteria.
Are LA structures detected in the air within an NPE where LA-contaminated dust was removed?	Living Space Clearance Air Samples	For each property undergoing LA-contaminated dust removal, stationary clearance air samples will be collected from within the NPE where the contaminated dust was removed. The results of the clearance air samples will be used to determine if LA contamination was removed to project-specific clearance criteria.
Is LA detected in the soil surface of the excavated area?	Confirmation Soil Samples	For each property undergoing contaminated soil removal, confirmation soil samples will be collected from the surface of the excavated area. The results of the confirmation soil samples will be used to determine if LA contamination was removed to project-specific clearance criteria.
Is vermiculite visible in the soil surface of the excavated area?	Confirmation Soil Samples	For each property undergoing contaminated soil removal, a semi-qualitative visual estimation of vermiculite will be performed on the surface of the excavated area. The results of the visual inspection will be used to determine if vermiculite was removed to project-specific clearance criteria.
Is vermiculite visible in the sidewalls of the excavated area?	VV Inspection	For each property undergoing contaminated soil removal, a semi-qualitative visual estimation of vermiculite will be performed on the sidewall of the excavated area. The results of the visual inspection will be used to determine if vermiculite was removed to project-specific clearance criteria.
Is vermiculite visible in surface soils adjacent to the excavation boundary or newly identified property areas?	VV Inspection	For each property undergoing contaminated soil removal, a semi-qualitative visual estimation of vermiculite will be performed in areas adjacent to the excavated areas and/or in newly identified property areas suspected of containing LA source materials. The results of the visual inspection will be used to determine if additional areas will require excavation to meet project-specific clearance criteria.
Is vermiculite visible in bulk building materials	VV Inspection	For properties undergoing resonse action, a visual inspection for vermiculite will be performed to identify if bulk building materials contain vermiculite. The results of the visual inspection will be used to determine if additional removal will be required to meet project specific clearance criteria.
Is LA detected in bulk building materials?	Collection of bulk building material samples for asbestos analysis	For each property undergoing a removal, bulk material samples may be collected from building materials if vermiculite cannot be positively identified visually within the material. The results of the bulk material samples will be used to determine if LA contamination is present in the building materials at individual properties for removal planning.

LA – Libby amphibole asbestos
OSHA – Occupational Safety and Health Administration
NPE – negative-pressure enclosure
VV – visible vermiculite

3.1.4 Step 4 – Define the Boundaries of the Study

This step specifies the spatial and temporal boundaries of this investigation.

3.1.4.1 Spatial Bounds

The information gathered to answer the objectives will be collected from residential, commercial, and industrial properties within the boundaries of the Libby Superfund Site (Figure 2-2). The vertical spatial boundaries extend from the highest point in a residential or commercial property, approximately two stories, to the deepest excavation completed, typically approximately 12 to 18 inches below ground surface (bgs) but may reach several feet bgs in certain circumstances.

3.1.4.2 Temporal Bounds

The temporal boundaries of this investigation include the time from when response actions begin at each property to the time clearance or confirmation samples are collected and meet project-specific clearance criteria.

3.1.5 Step 5 – Develop Decision Rules

The purpose of this step is to describe the method that the EPA will use to determine if the data collected indicate acceptance (i.e., usability) and the resulting decision applied when acceptance is not obtained. The data will also be used to determine if additional removal actions are warranted in order to achieve cleanup goals (EPA 2003, 2011). The principal study question, inputs to resolve study questions, action levels, and decision rules are summarized in Table 3-3.

Table 3-3. Decision Rules

Principal Study Question	Input to Resolve Question	Input Requirements	Action Level	Decision Rule
Are fibers detected in the workers' breathing zone above worker safety limits?	Personal Air Samples	Analysis: PCM by NIOSH 7400; TEM Asbestos Hazard Emergency Response Act (AHERA) with site-specific modifications AS_{PCM}: 1 f/cc AS^{1}_{TEM}: ~0.005 s/cc Minimum Volume: 25 L/sample Collect: 8-hour TWA; 30-minute STEL excursion sample	TWA: 0.1 PCME f/cc STEL: 1.0 f/cc	If sample results exceed the action level or samples are overloaded, engineering controls, work practices, and/or PPE will be evaluated by the removal contractor and presented to a USACE representative. In addition, the sample may be analyzed by TEM AHERA (using indirect preparation methods if necessary) for confirmation of LA for informational purposes only. Collect additional air samples as deemed necessary. If the sample is not overloaded and the results are detected below the worker safety limits, take no action.

Table 3-3. Decision Rules (Continued)

Principal Study Question	Input to Resolve Question	Input Requirements	Action Level	Decision Rule
Are LA structures in ambient air migrating beyond the exclusion zone boundary during contaminated soil removal activities?	Perimeter Air Samples	Analysis: TEM AHERA with site-specific modifications AS[1]: ~0.005 s/cc Minimum Volume: 1200 L/sample Collect: 1 sample along exclusion zone downwind of excavation	≥ 2 LA structures on one sample	If sample results exceed the action level or samples are overloaded, then engineering controls and work practices will be evaluated by the removal contractor and presented to a USACE representative. Collect additional air sample as deemed necessary. If the sample is not overloaded and results are below the action level, take no action.
Are LA structures detected in stored water used for response actions (e.g., trucks, tanks, etc.)?	Water Samples	Analysis: TEM - ISO Method 10312 AS: 0.2 MFL Minimum Volume: 1L Sampling frequency not established. Samples will be collected at the A&E's discression or upon request by the RC.	0.2 MFL per sample	If sample results exceed the action level, then the water storage equipment will be taken out of service, flushed with LA free water. Collect additional water sample. If structure concentrations are not detected, or are below the action level, take no action.
Are LA structures detected in ambient or exhaust air of equipment utilized by the removal contractor?	Equipment Air Monitoring Samples	Analysis: TEM AHERA with site-specific modifications AS[1]: ~0.005 s/cc Minimum Volume: 1200 L/sample Collect: 1 sample within decontamination trailer clean room; 1 sample of equipment exhaust air	1 LA structure on one sample or overloaded	If decontamination trailer clean room ambient air sample results exceed the action level or samples are overloaded, then the decontamination trailer clean room will be thoroughly wet-wiped and vacuumed with a HEPA vacuum by the removal contractor and work practices will be evaluated by the removal contractor supervisor(s). Collect additional air sample. If exhaust air sample results exceed the action level or samples are overloaded, then the equipment will be inspected by the TQA, work practices will be evaluated, and HEPA filters will be replaced (if applicable) by the removal contractor. Collect additional air sample. If LA structures are not detected, take no action.

Table 3-3. Decision Rules (Continued)

Principal Study Question	Input to Resolve Question	Input Requirements	Action Level	Decision Rule
Are chlorine residuals detected in potable water storage equipment?	Water Samples	Analysis: TQA staff will use a portable colorimeter (HACH Pocket Colorimeter™ II, HACH Total Chlorine Test Strips, or equivalent)	<.1 mg/cc or > 4 mg/cc chlorine residuals detected (Acceptable range for residual chlorine in potable water is between 0.1 mg/cc and 4.0 mg/cc)	If residual chlorine results from potable water storage equipment water samples are outside the acceptable range, then the water cannot be used for personnel decontamination purposes. The removal contractor will apply the recommended amount of chlorine or dilute with additional water. Collect additional water sample. If residual chlorine is detected between 0.1 mg/cc and 4.0 mg/cc (acceptable range), take no action.
Are LA structures detected in the air within an NPE where vermiculite insulation was removed?	Non-living Space Clearance Air Samples	Analysis: TEM AHERA with site-specific modifications AS: 0.005 s/cc Minimum Volume: 1200 L/sample Collect: 5 samples of disturbed air within NPE	≤ 5 LA structures over 5 samples	Following vermiculite insulation removal activities, if sample results exceed the action level or samples are overloaded, then the area will be re-cleaned by the removal contractor. Collect additional air samples. If sample results are below the action level, then the area is acceptably cleaned.
Are LA structures detected in the air within an NPE where LA-contaminated dust was removed?	Living Space Clearance Air Samples	Analysis: TEM AHERA with site-specific modifications AS: 0.005 s/cc Minimum Volume: 1200 L/sample Collect: 5 samples of disturbed air within NPE	1 LA structure over 5 samples	Following LA-contaminated indoor dust removal activities, if sample results exceed the action level or samples are overloaded, then the area will be re-cleaned by the removal contractor. Collect additional samples. If LA structures are below the action level, then the area is acceptably cleaned.

Table 3-3. Decision Rules (Continued)

Principal Study Question	Input to Resolve Question	Input Requirements	Action Level	Decision Rule
Is LA detected in the soil surface of the excavated area?	Confirmation Soil Samples	Analysis: PLM by NIOSH 9002 Reported Result: % LA by VAE AS: Method defined as 1%, but qualitative estimates of LA present below 1% reported as <1% or ND Approximate Sample Mass: 1 kilogram	Any detectable LA for samples collected shallower than design depth, ≥1% LA for samples collected at design depth or deeper	If, at less than the excavation depth as defined in the site-specific removal work plan, LA is detected in confirmation soil samples, then excavation will advance to the design depth to the extent possible. If excavation to design depth is limited due to site features (e.g., tree roots, building foundations, etc.), the area(s) and associated sample data will be demarcated on property documentation. If, at depths equal to or greater than the excavation depth defined in the site-specific removal work plan, ≥1% LA is detected in confirmation soil samples, then excavation will advance in 6-inch or greater increments to a maximum depth of 3 feet bgs. This iterative sampling process will occur after each 6-inch increment has been removed until soil cleanup levels (<1% LA) are achieved. If LA in soil is at or below respective action level for samples collected at depth, then the area is acceptably cleaned.
Is vermiculite visible in the soil surface of the excavated area?	Confirmation Soil Samples	CDM-LIBBY-13	VV as observed using CDM-LIBBY-13	If high quantities of vermiculite are observed in the excavated soil surface, the excavation will advance in 6-inch increments to a maximum depth of 3 feet bgs. This iterative process will occur after each 6-inch increment has been removed until desired levels are achieved. If no, low, or intermediate vermiculite is observed in the excavated soil surface at design depth, then the area is acceptable and can be sampled.

Table 3-3. Decision Rules (Continued)

Principal Study Question	Input to Resolve Question	Input Requirements	Action Level	Decision Rule
Is vermiculite visible in the sidewalls of the excavated area?	Confirmation Soil Samples	CDM-LIBBY-13	VV as observed using CDM-LIBBY-13	If low, intermediate, or high quantities of vermiculite are observed in soil surface of the excavated sidewall, the excavation will advance laterally in approximately 12-inch increments. This iterative process will occur until no quantities of vermiculite are observed and/or the boundary of the property is reached. If no vermiculite is observed in the excavated surface, then the area is acceptable and can be sampled.
Is vermiculite visible in surface soils adjacent to the excavation boundary or newly identified property areas?	Visual Inspections	CDM-LIBBY-16, and methods as described in Section 4.6.2	VV as observed using CDM-LIBBY-16	If two or more vermiculite flakes are observed within an inspection zone during a PI, the zone will be excavated. If one vermiculite flake is observed within an inspection zone during a PI, perform an additional 5 follow up PIs within the same zone. If vermiculite is not observed, take no action. During the follow up (second set) PIs, use the same decision rules as the initial PI. If during the third and final set of 5 PIs, any vermiculite is observed, the zone will be excavated. If vermiculite is not observed, take no action.
Is vermiculite visible in bulk building materials?	Visual Inspections	Method as described in section 4.9	Observed VV	If VV is observed in bulk material, the A&E will assess its condition and a response action will be approved by a government representative.

Table 3-3. Decision Rules (Continued)

Principal Study Question	Input to Resolve Question	Input Requirements	Action Level	Decision Rule
Is LA detected in bulk building materials?	Bulk Material Samples	Analysis: PLM by NIOSH 9002 Reported Result: % LA AS: Method defined as 1%, but qualitative estimates of LA present below 1% reported as less than 1% or ND	Any detectable LA	If LA is detected in any bulk material samples, the A&E contractor will notifiy the project management team, and a government representative will approve any response action taken. If LA is not detected in any bulk material sample, take no action.

% – percent
AS – analytical sensitivity
cc – cubic centimeters
EPA – Environmental Protection Agency
HEPA – high efficiency particulate air
L – liters
LA – Libby amphibole asbestos
MFL – million fibers per liter
mg/cc – milligrams per cubic centimeter
ml – milliliters
ND – nondetect
NIOSH – National Institute for Occupational Safety and Health
NPE – negative-pressure enclosure
PCME – phase contrast microscopy equivalent PI – point inspection
PPE – personal protective equipment
RAWP – Removal Action Work Plan
STEL – short-term exposure limit
TEM – transmission electron microscopy
TQA – third-party quality assurance
TWA – time-weighted average
USACE – U.S. Army Corps of Engineers
VAE – visual area estimation
VV – visible vermiculite

[1] The laboratory will attempt to achieve the method AS of 0.005 s/cc using direct sample preparation techniques and will employ project-specific stopping rules as documented in Laboratory Modification #LB-000017.

3.1.6 Step 6 – Specify Tolerable Limits on Decision Errors

The tolerable limits on decision errors, used to establish performance goals for the data collection design, are specified in this step.

Specific to the collection of response action clearance air and confirmation soil samples, two types of decision errors are possible:

- A Type I (false negative) decision error would occur if a risk manager decides that the sample does not contain LA above a level of concern, when in fact it is of concern.
- A Type II (false positive) decision error would occur if a risk manager decides that levels of LA in samples are above a level of concern, when in fact they are not.

The EPA is most concerned about guarding against the occurrence of Type I errors, since an error of this type may leave humans exposed to unacceptable levels of LA.

The EPA is also concerned with the probability of making Type II (false positive) decision errors. Although this type of decision error does not result in unacceptable human exposure, it may result in unnecessary expenditure of resources.

For the purposes of completing all six steps of the DQO process, the null hypotheses and consequences of making an incorrect decision are summarized in Table 3-4. However, the gray region and tolerable limits on decision errors are not proposed because they are not applicable in this case.

Typically, Step 6 of the DQO process is useful to encourage careful design of decision rules by defining and integrating the errors that are acceptable based upon a myriad of integrated project management decisions, such as reduction in risk to human health, implementability/practability, and cost. As stated in the guidance document for development of DQOs: QA/G-4 (EPA 2006), solely statistically-generated tolerable limits on decisions errors are not necessary in certain cases providing a line of reasoning (scientific justification) is presented that adequately defines acceptable limits or decision errors. This particular effort was put forth in the Action Level/Clearance Criteria Technical Memorandum (EPA 2003, 2011) for the following parameters: (1) soil confirmation samples; (2) perimeter monitoring air samples; (3) air clearance for vermiculite insulation removal; and (4) air clearance for indoor dust removal. The decision rule for the personal breathing zone air monitoring samples has been promulgated by legislation, and as such, limits on decision errors do not apply.

3.1.7 Step 7 – Optimize the Design for Obtaining Data

This step identifies a resource-effective data collection design for generating data that are expected to satisfy the DQOs. The data collection design is described in detail in the remaining sections of this RA SAP and other site documents referenced in Section 4.

Using data previously generated for the site, the DQOs have been designed to support the proposed response activities under the RAWP and represent the best possible project planning effort. However, in implementing the requirements contained in this RA SAP, unforeseen situations may arise or team members may find more efficient means to carry out some of the day-to-day activities. Therefore, team members are always afforded the opportunity to recommend optimization of the data-gathering design. Recommendations must come through proper channels (i.e., through the Project Manager or field team leader [FTL]) and documented using either a Libby Asbestos Project Record of Modification (ROM) Form[1] or an addendum to this RA SAP. All modifications or addendums must be reviewed and approved by the EPA and USACE prior to making the proposed changes.

3.2 Data Quality Criteria

3.2.1 Precision

The precision of asbestos measurements is determined mainly by the number (N) of asbestos structures counted in each sample. The coefficient of variation resulting from random point counting error is equal to $1/N^{0.5}$. In general, when good precision is needed, it is desirable to count a minimum of 3 to 10 structures per sample, with counts of 20 to 25 structures per sample being optimal. R

In addition, laboratory quality control (QC) measurements (both inter- and intra-laboratory) will provide information on analysis reproducibility and precision. This laboratory QC consists of recount and repreparation analyses for TEM analysis, and laboratory duplicate and standard reference materials for PLM (see Section 5.1).

3.2.2 Bias and Representativeness

To the extent feasible, samples should be collected and analyzed in accordance with procedures that have been performed in previous (and planned future) response action sampling efforts of air, soil,

[1] The most recent version of the Analytical Laboratory ROM Form is available in the Libby Lab eRoom. Field ROM Forms are are available from and maintained by the A&E Libby Quality Assurance Manager.

water, and bulk material. This will ensure that the results of this study are representative and appropriate for comparison to other data sets.

3.2.3 Completeness

Target completeness for this project is 100%. If any samples are not collected, or if LA analysis is not completed successfully, this could result in that portion of the study providing no useful information. In this event, additional sampling may be needed to support EPA decision-making.

3.2.4 Comparability

The data generated during this study will be obtained using standard analytical methods for LA that have been utilized previously in other studies, and will yield data that are comparable to previous analyses of LA in response action air, soil, water, and bulk material.

3.2.5 Method Sensitivity

The method sensitivity (analytical sensitivity) needed for LA analysis of each medium is discussed earlier in this section, as well as Section 5.1.

Table 3-4. Limits on Decision Errors

Principal Study Question	Null Hypothesis	Type I Error	Type II Error
Are fibers detected in the workers' breathing zone above worker safety limits?	The breathing zone air is contaminated with nuisance dust and/or LA above the worker safety action levels.	Determining that the breathing zone air is not contaminated with fibers and/or LA above the worker safety action levels when it actually is. May result in an increased risk to workers performing removal actions.	Determining that the breathing zone air is contaminated with nuisance dust and/or LA above the worker safety action levels when it is not. May result in re-evaluating engineering controls, possibly stopping work, or increasing the level of PPE when it is not necessary, adding unnecessary cleanup costs.
Are LA structures in ambient air migrating beyond the exclusion zone boundary during contaminated soil removal activities?	The perimeter air is contaminated with LA.	Determining that the perimeter air is not contaminated with LA when it actually is. May result in an increased risk to human health.	Determining that the perimeter air is contaminated with LA when it is not. May result in re-evaluating engineering controls and possibly stopping work when it is not necessary, adding unnecessary cleanup costs.
Are LA structures detected in stored water (e.g., trucks, tanks, etc.)?	Dust suppression and decontamination water used by the removal contractor is contaminated with LA.	Determining that water from water tanks is not contaminated with LA when it actually is. May result in an increased risk to human health.	Determining that water (and/or water tanks) is contaminated with LA when it is not. May result in re-evaluating water sources, engineering controls, and possibly stopping work when it is not necessary, adding unnecessary cleanup costs.
Are LA structures detected in ambient or exhaust air of equipment utilized by the removal contractor?	The ambient air is contaminated with LA as a result of equipment being used by the removal contractor.	Determining that the ambient air is not contaminated with LA when it actually is. May result in an increased risk to human health.	Determining that the ambient air is contaminated with LA when it is not. May result in unnecessary maintenance, evaluation of engineering controls, and possibly stopping work when it is not necessary, adding unnecessary cleanup costs.
Are chlorine residuals detected in potable water storage equipment?	Potable water lacks sufficient or contains excessive chlorine presenting a health risk to workers.	Determining that potable water has an appropriate concentration of residual chlorine when it actually does not. May result in an increased risk to worker health.	Determining that potable water does not have an appropriate concentration of residual chlorine when it actually does. May result in unnecessary maintenance to the potable water supply, adding unnecessary cleanup costs.
Are LA structures detected in the air within an NPE where LA-contaminated dust was removed?	The NPE (living space) that was previously contaminated with LA is still contaminated with LA after removal.	Determining that the NPE that was previously contained LA-laden dust is not contaminated with LA after removal when it actually is. May result in an increased risk to human health.	Determining that the NPE that previously contained LA-laden dust is contaminated with LA after removal when it is not. May result in unnecessary re-cleaning of the NPE, adding unnecessary cleanup costs.
Is LA detected in the soil surface of the excavated area?	The soils below an excavation are still contaminated with LA after removal.	Determining that the surface soils at the bottom of the excavated area are not contaminated with LA when they actually are. May result in an increased risk to human health.	Determining that the surface soils at the bottom of the excavated area are contaminated with LA when they are not. May result in excavation of additional soils when it is not necessary, adding unnecessary cleanup costs.
Is vermiculite visible in the soil surface of the excavated area?	The soils below an excavation still contain high quantities of vermiculite.	Determining that the surface soils at the bottom of the excavated area do not contain high quantities of vermiculite when they actually do. May result in an increased risk to human health.	Determining that the surface soils at the bottom of the excavated area do contain high quantities of vermiculite when they do not. May result in excavation of additional soils when it is not necessary, adding unnecessary cleanup costs.

Table 3-4. Limits on Decision Errors (Continued)

Principal Study Question	Null Hypothesis	Type I Error	Type II Error
Is vermiculite visible in the sidewalls of the excavated area?	The soils adjacent to an excavation within design depth contains low, intermediate, or high quantities of vermiculite.	Determining that the adjacent soils of an excavation do not contain any quantities of vermiculite when they actually do. May result in an increased risk to human health.	Determining that the adjacent soils of an excavated area do contain high quantities of vermiculite when they do not. May result in excavation of additional soils when it is not necessary, adding unnecessary cleanup costs.
Is vermiculite visible in surface soils adjacent to the excavation boundary or newly identified property areas?	The soils adjacent to an excavation boundary or in newly identified property areas contain low, intermediate, or high quantities of vermiculite.	Determining that the adjacent soils of an excavation boundary or in newly identified areas do not contain any quantities of vermiculite when they actually do. May result in an increased risk to human health.	Determining that the adjacent soils of an excavated boundary or in newly identified areas do contain quantities of vermiculite when they do not. May result in excavation of additional soils when it is not necessary, adding unnecessary cleanup costs.
Is vermiculite visible in bulk building materials?	Building materials do not contain vermiculite.	Determining that building materials do not contain vermiculite when they actually do. May result in an increased risk to human health.	Determining that building materials contain vermiculite when they actually do not. May result in removing building materials when it is not necessary, adding unnecessary cleanup costs.
Is LA detected in bulk building materials?	Building materials that do not contain vermiculite are not contaminated with LA.	Determining that building materials that do not contain vermiculite are not contaminated with LA when they actually are. May result in an increased risk to human health.	Determining that building materials containing vermiculite are contaminated with LA when they actually are not. May result in removing building materials when it is not necessary, adding unnecessary cleanup costs.

Section 4
Sampling Program

This section summarizes field activities that will be performed by A&E staff in support of Libby response actions. This section also provides brief summaries of standard operating procedures (SOPs), which include project-specific modifications where applicable and project-specific details not discussed in the SOPs. For comprehensive information, field personnel will refer to the general and project-specific SOPs included in Appendix A. The Libby Asbestos Project Comprehensive Accident Prevention Plan (CAPP) (CDM Smith 2011a) and the A&E's Accident Prevention Plan (APP) (CDM Smith 2011b) should be consulted to determine health and safety protocols for performing the site work required by this RA SAP.

All field activities will be performed in accordance with this RA SAP. The current versions of the following procedures will be employed:

Procedure Number	Title
(none)	Appendix A to Subpart E of Part 763—Interim Transmission Electron Microscopy Analytical Methods—Mandatory and Non-mandatory—and Mandatory Section to Determine Completion of Response Actions
(none)	Sampling and Analysis – Non-mandatory, Title 29 Code of Federal Regulations (CFR), Part 1926.1101, Air Monitoring Frequencies - Appendix B
EPA-LIBBY-2012-01	Field Logbook Content and Control
EPA-LIBBY-2012-02	Photographic Documentation of Field Activities
EPA-LIBBY-2012-03	Control of Measurement and Test Equipment
EPA-LIBBY-2012-04	Field Equipment Decontamination
EPA-LIBBY-2012-05	Handling Investigation-derived Waste (IDW)
EPA-LIBBY-2012-06	Sample Custody
EPA-LIBBY-2012-07	Packaging and Shipping Environmental Samples
CDM-LIBBY-03	Completion of Field Sample Data Sheets (FSDS)
CDM-LIBBY-13	30-point Confirmation Soil Sampling
CDM-LIBBY-14	Stationary Air Sample Collection
CDM-LIBBY-16	Semi-quantitative Visual Estimation of Vermiculite in Soils during Removal Activities

The following sections are a summary of field activities that will be performed during the performance of the sampling and visual inspection efforts described in this RA SAP.

Analytical methods for all samples collected in accordance with this RA SAP are discussed in detail in Section 5.

4.1 Pre-sampling Activities

4.1.1 Field Planning Meeting

Prior to beginning field activities, a field planning meeting (FPM) will be conducted by the A&E FTL. The FPM will be attended by A&E field team members conducting the work (i.e., TQA staff, sample technicians, and sample coordination staff), as well as an A&E quality assurance (QA) staff member and health and safety staff member. The FPM agenda, prepared by the FTL using a standard form

developed by the A&E, will be reviewed and approved by the attending QA and health and safety staff prior to the FPM. The FPM will briefly discuss and clarify:

- Documents governing fieldwork that must be onsite
- Any changes in the governing documents
- Objectives and scope of the fieldwork
- Equipment and training needs
- Field operating procedures, schedule of events, and individual assignments
- Required field QC measures
- Required field audits or surveillances
- Health and safety requirements

During the FPM, copies of the agenda will be distributed and an attendance list will be circulated for signature. The agenda and the completed attendance list will be maintained in the A&E's Libby project office files. Additional meetings will be held when major changes to the documents governing field work occur, or when the scope of the assignment changes significantly.

Field team members will perform the following activities before and during field activities, as applicable:

- Review and understand applicable governing documents
- Record appropriate levels of documentation for activities conducted
- Ensure coordination between key staff
- Ensure that all sample analyses are scheduled through the laboratory coordinator
- Obtain required sample containers and other supplies
- Obtain, check, and calibrate field sampling equipment
- Obtain and maintain personal protective equipment (PPE)

4.1.2 Field Team Training Requirements

Prior to starting work described in this document, any new field team member must complete the following, at a minimum:

- Read the CAPP and A&E APP (CDM Smith 2011a, 2011b)– completion of this requirement will be documented on the respective health and safety plan signature sheet[a]
- Attend an orientation session with the A&E's onsite health and safety officer – completion of this requirement will be documented on an orientation session attendance sheet[a]
- Read and understand relevant governing documents – completion of this requirement will be documented on a specific required reading report[b]

- Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste Operations and Emergency Response certification and relevant 8-hour refresher course certifications – completion of this requirement will be documented by training certificates[a]
- Respiratory protection course certification as required by 29 CFR 1910.134 – completion of this requirement will be documented by training certificates[a]
- Asbestos awareness course certification as required by 29 CFR 1910.1001 – completion of this requirement will be documented by training certificates[a]
- Training on sample collection techniques – completion of this requirement will be documented on training session attendance sheets[b]
- Training on the identification of vermiculite and Libby mine-related materials – completion of this requirement will be documented on training session attendance sheets[b]

[a]documentation maintained by onsite A&E health and safety staff
[b]documentation maintained by the A&E FTL

Copies of all documentation of trainings/certifications will be stored in the A&E's Libby project office files.

4.1.3 Inventory and Procurement of Equipment and Supplies

The following equipment is required for sampling activities conducted under this RA SAP. A member of the A&E's health and safety staff will be responsible for maintaining adequate inventory of required supplies and ensuring the supplies are readily available for field use. Any required equipment not already contained in the field equipment supply inventory will be procured prior to initiation of sampling activities and acceptance verified according to EPA-LIBBY-2012-03, Control of Measurement and Test Equipment (Appendix A), when applicable:

- Field logbooks
- Indelible ink pens
- Digital camera with memory card, as appropriate
- Rotameter
- High-volume (electric powered) and low-volume (battery powered) air sampling pumps
- Air sample media: 25 millimeter (mm) diameter mixed cellulose ester (MCE) filter cassettes with 0.8 micrometer (µm) filter pore size
- Sample paperwork and sample tags/labels
- Custody seals
- Plastic zipper-top bags
- Soil sampling equipment
- Pin flags

- Measuring wheel, measuring tape, or other measuring device
- Hach Company Pocket Colorimeter TM II, Total Chlorine Test Strips, or equivalent, and other laboratory-provided bottle ware for water testing and sampling
- PPE as required by the CAAP and A&E APP

4.2 Stationary Air Samples

This section describes the sampling rationale, methods, and procedures that will be used to collect response action stationary air samples. Stationary air samples are air samples collected at a fixed location for a specified duration to meet project-specific goals. The three types of stationary samples collected in support of response actions are:

- Perimeter air samples
- Clearance air samples
- Equipment monitoring samples

Descriptions of these samples, and requirements for their collection, are provided in the following sections.

4.2.1 Perimeter Air Samples

For the purposes of this document, perimeter air samples are collected to determine the effectiveness of work practices and engineering controls at preventing offsite migration of airborne LA during exterior response actions. The site-specific removal work plan should be referenced to determine if an exterior response action is required.

4.2.1.1 Perimeter Air Sampling Rationale

During the removal of LA-contaminated soils in exterior response actions, the downwind perimeter of the exclusion zone will be monitored for LA emissions by the collection of a stationary air sample at the exclusion zone boundary. The location of the perimeter air samples placed along the exclusion zone boundary will be determined by field sampling personnel after the exclusion zone fencing has been installed by the removal contractor and the dominant wind direction during the day of sampling is identified. In general, one perimeter sample will be located downwind of the excavation, immediately outside of the exclusion zone fencing. Perimeter air samples will remain in the same location even if wind direction changes during sampling period; however, wind shift will be documented accordingly in the logbook. Perimeter air samples will be collected when exterior response actions require the removal of contaminated soils. Often times the duration of the removal action will be less than the required run time for stationary air sample collection. In these instances a perimeter air sample will not be collected (e.g., half day of excavation). Sample collection will cease once all contaminated soils have been removed from an exclusion zone. Data from these perimeter air samples will be compared against project-specific action levels stated in Table 3-3 to evaluate removal work practices and engineering controls.

4.2.1.2 Perimeter Air Sampling Methods

All perimeter air samples will be collected in accordance with the project-specific SOP CDM-LIBBY-14, Stationary Air Sample Collection (Appendix A). Each perimeter air sample will be collected at a rate of 1.0 to 10.0 liters per minute (L/min) and have a minimum volume of 1,200 liters. The flow rate will be

set depending upon the type of sampling pump used (i.e., high versus low volume) and expected duration of the sampling period.

Perimeter air samples will be analyzed by transmission electron microscopy (TEM) as defined in the Asbestos Hazard Emergency Act (AHERA) (EPA 1987), as discussed in Section 5.

4.2.1.3 Field QC Samples

The field QC samples associated with perimeter air samples are lot blanks and field blanks. These sample types are discussed in this section and summarized in Table 4-1.

Table 4-1. Summary of Field QC Samples

Sample Type	Associated QC Sample	Collection Frequency	Analysis Frequency	Analysis Request[1]	Acceptance Criteria
Perimeter Stationary Air	lot blank	1 lot blank per 500 unused sample cassettes[2]	same as collection frequency	PCM and TEM AHERA	7 or more f/cc by PCM or 1 or more LA s/cc by TEM AHERA
Perimeter Stationary Air	field blank	1 per team per day	1 per team per week	TEM AHERA	1 or more LA s/cc by TEM AHERA
Clearance Stationary Air	lot blank	1 lot blank per 500 unused sample cassettes[2]	same as collection frequency	PCM and TEM AHERA	7 or more f/cc by PCM or 1 or more LA s/cc by TEM AHERA
Clearance Stationary Air	field blank	2 per set of 5 clearance field samples	same as collection frequency	TEM AHERA	1 or more LA s/cc by TEM AHERA
Equipment Monitoring Stationary Air	lot blank	1 lot blank per 500 unused sample cassettes[2]	same as collection frequency	PCM and TEM AHERA	7 or more f/cc by PCM or 1 or more LA s/cc by TEM AHERA
Equipment Monitoring Stationary Air	field blank	1 per team per day	1 per team per week	TEM AHERA	1 or more LA s/cc by TEM AHERA
Personal Air	lot blank	1 lot blank per 500 unused sample cassettes[2]	same as collection frequency	PCM and TEM AHERA	7 or more f/cc by PCM or 1 or more LA s/cc by TEM AHERA
Personal Air	field blank	1 per team per day	1 per team per week	PCM or TEM AHERA[3]	1 or more LA s/cc by TEM AHERA
Confirmation Soil	none	not applicable	not applicable	not applicable	not applicable
Water sample	none	regular and frequent, but not quantified	same as collection frequency	TEM by ISO 10312	not applicable
Bulk Material	none	As needed and not quantified	same as collection frequency	PLM by NIOSH 9002	not applicable

LA – Libby amphibole asbestos
PCM – phase contrast microscopy, TEM – transmission electron microscopy
f/cc – fibers per cubic centimeter, s/cc – structures per cubic centimeter
[1] All project-specific method modifications apply, as specified in the Sampling and Analysis Plan Analytical Summary Sheet (Appendix C).
[2] Since the same type of cassette is used for all air samples, lot blanks may be submitted collectively for these sample types.
[3] Personal air sample field blanks will be analyzed using the same method as the field samples submitted on the same chain-of-custody(COC) form.

Lot Blanks

Lot blanks are prepared by submitting unused cassettes for analyses prior to putting the group (i.e., lot) of cassettes into use. Lot blanks will be collected and analyzed at a frequency of 1 per 500 cassettes from the same lot. The lot blanks will be analyzed by phase contrast microscopy (PCM) (National Institute for Occupational Safety and Health [NIOSH] 1994a) and TEM AHERA (EPA 1987), with applicable project-specific laboratory modifications. Lot blanks will be identified on the COC form so that the analytical laboratory is aware of their use and can immediately notify the appropriate parties if asbestos fibers are detected on the filters. If the lot is proved to be contaminated with seven or more fibers per cubic centimeter (f/cc) by PCM or one or more LA structures per cubic centimeter (s/cc) by TEM AHERA, then the lot of cassettes will be discarded and a new lot of cassettes will be acceptance tested.

Field Blanks

Each field team collecting stationary air samples will collect one field blank per day of air sampling. The field blank cassettes will come from the same lot as the cassettes used that day for air sample collection. One field blank per field team will be analyzed per week at the discretion of the A&E sample coordinator, whose responsibility it is to submit the appropriate number of field blanks for analysis. The remainder of the field blanks collected by field teams, but not analyzed, will be submitted to the analytical laboratories marked for archive. The field blanks will be analyzed by TEM AHERA (EPA 1987), with applicable project-specific laboratory modifications. The field blanks sample results will be reviewed by the sample coordinator in conjunction with the A&E FTL. If any LA is detected on a field blank, then the FTL will contact appropriate field personnel to determine whether the occurrence displays a trend in poor sample collection technique or is isolated. If field blank contamination appears to be a consistent deficiency at the field level, the FTL will immediately re-train field staff on proper sample collection. If the field blank contamination appears unrelated to field processes, the laboratory coordinator may request that additional field blanks be analyzed and will discuss any quality issues with the analytical laboratory analyzing the field blanks.

4.2.2 Clearance Air Samples

If a property requires the removal of vermiculite insulation, LA-contaminated interior dust or soil floors, and/or LA-contaminated building materials, clearance air samples will be collected following removal activities. Clearance air samples are collected to determine if interior LA contamination levels have been reduced to project-specific action levels by interior response actions. The current version of the RAWP and site-specific removal work plan should be referenced to determine if an interior response action is required.

4.2.2.1 Clearance Air Sampling Rationale

Clearance air samples are collected from living spaces (e.g., living room, bedroom, hallway, kitchen, garage, crawlspace, basement, etc.) and non-living spaces (e.g., attic) where LA-contaminated media (e.g., insulation, interior dust, building materials, etc.) are removed. Secondary buildings (e.g., sheds, greenhouses, etc.) will be sampled in accordance with building-type designation as described in the RAWP. After the removal contractor has removed the contaminated material, a TQA staff member will perform a visual inspection of the area to determine if clearance air sampling may commence. The visual inspection will consist of but is not limited to: confirming visible vermiculite (VV) (insulation) has in fact been removed, any blocking that was installed is of adequate construction, and any encapsulant that was applied is dry. Results of the visual inspection will be documented in the field log book or quality assurance report (QAR). Clearance air samples will be collected to determine if

interior response actions were successful at meeting the project-specific action levels. If sample results do not meet project-specific action levels, additional cleaning will be performed and clearance samples re-collected. This iterative process will continue until project-specific action levels, as stated in Table 3-3, have been met. Once the action levels have been met, the area will be designated as adequately cleaned and restoration activities may begin.

4.2.2.2 Clearance Air Sampling Methods

Prior to collecting clearance air samples, a TQA staff member will determine whether the area being sampled (cleared) is considered a living space or non-living space in order to compare the data collected to the project-specific action levels specified for these two different areas. The location of clearance air samples is dependent upon the size, type, and dimensions of each containment area requiring sample collection. Five clearance samples will be collected in each containment area where a response action was performed. In cases where an attic shares air space with a living area and is included within the same negative-pressure enclosure (NPE), the area must meet the project-specific action level for a living space as stated in Table 3-3. The reader is referred to the current version of the RAWP for more detail regarding preparing NPEs for clearance air sampling.

Each clearance air sample will be collected in accordance with TEM AHERA sampling guidance (EPA 1987) (Appendix A), with the following modifications:

Section II, B, 5 – 0.8 µm MCE cassettes will be used in place of MCE cassettes having a pore size less than or equal to 0.45 µm.

Section II, B, 17 – A total of 7 air samples will be collected for each testing site (5 field samples and 2 field blanks) rather than a minimum of 13 samples. No samples will be collected in ambient areas entering the abatement site (i.e., containment area). Both field blanks will be taken inside the abatement area (i.e., containment area) in place of one blank sample taken near the entrance and one taken at the ambient site. No sealed blank will be carried with each sample set.

Section II, B, 24 – Field QC Samples and DQOs will be followed as discussed in this RA SAP.

All clearance air samples will be analyzed by TEM AHERA (EPA 1987), with applicable project-specific laboratory modifications as discussed in Section 5.

4.2.2.3 Field QC Samples

The Field QC samples associated with clearance air samples are lot blanks and field blanks. These sample types are discussed in this section and summarized in Table 4-1.

Lot Blanks

Lot blanks will be prepared and submitted as described in Section 4.2.1.3. Because the same type of sample cassette is used for the collection of perimeter, clearance, equipment monitoring, and personal air samples, lot blanks may be submitted collectively for these samples types. The analysis of and acceptance criteria for the lot blanks for clearance samples will be the same as for perimeter air samples (Section 4.2.1.3).

Field Blanks

Each field team will collect two field blanks per containment area (i.e., NPE). The field blanks will come from the same lot as the cassettes used that day for air sample collection. Both of the field blanks will be collected within the removal area, in close proximity to any one of the clearance air sample

locations. The field blanks will be analyzed by TEM AHERA (EPA 1987), with applicable project-specific laboratory modifications. As with perimeter air field blanks, if a clearance field blank indicates any LA contamination, field and laboratory processes, as necessary, will immediately be evaluated as described in Section 4.2.1.3.

4.3 Equipment Air Monitoring

Equipment air monitoring samples will be collected from various equipment used by the removal contractor during response action activities. Although there are no established frequencies for equipment air monitoring samples, a TQA staff member will collect samples as deemed necessary by government representatives affiliated with the Libby project. Examples of equipment air monitoring samples include negative air machines, trailer-mounted or truck-mounted high-power vacuum units (e.g., Hurricane, etc.).

4.3.1 Equipment Air Monitoring Rationale

The purpose of the equipment air monitoring samples is to determine if the removal contractor is operating and maintaining removal equipment in accordance with the site and/or manufacturer's specifications. Depending on equipment utilized by the removal contractor, equipment to be sampled includes:

- Decontamination trailers – clean room, once per week per site
- Negative-air machines – exhaust air, as necessary
- High-powered vacuum units – exhaust air, as necessary

This list is not intended to be all inclusive. TQA staff or A&E health and safety staff may identify other equipment to monitor throughout the duration of removal activities. If additional equipment is identified as requiring sampling, it will first be discussed with the USACE representative.

4.3.2 Equipment Air Monitoring Methods

All equipment air monitoring samples will be collected in accordance with CDM-LIBBY-14, Stationary Air Sample Collection (Appendix A). Each perimeter air sample will be collected at a rate of 1.0 to 10.0 L/min and have a minimum volume of 1,200 liters. Data from these equipment air monitoring samples will be compared against project-specific action levels stated in Table 3-3 to evaluate equipment maintenance.

All equipment air monitoring samples will be analyzed by TEM AHERA (EPA 1987) with applicable project-specific laboratory modifications as discussed in Section 5. Task-based air monitoring frequency for the project is summarized in Appendix B.

4.3.3 Field QC Samples

The field QC samples associated with equipment air monitoring sampling are lot blanks and field blanks. These field QC samples will be collected and analyzed, and sample results evaluated in the same manner as perimeter air samples, which are discussed in Section 4.2.1.3 and summarized in Table 4-1.

4.4 Personal Air Sampling

Personal air samples are collected to determine if the respiratory protection used by personnel conducting response actions continues to be adequate to protect worker health. To determine if respiratory protection continues to be adequate, sample results should be compared to OSHA standard 29 CFR 1926.1101, which are provided in Table 3-3.

4.4.1 Personal Air Sampling Rationale

During response actions, personal air samples are collected to ensure worker health is protected. Sampling frequencies for personal air samples were established using task-based personal air sampling data collected during the 2002 and 2003 field seasons in Libby.

For interior response actions, personal air samples are collected on personnel performing the following activities: vermiculite insulation removal, demolition, attic detailing, wet-wiping and/or HEPA vacuuming living spaces. For exterior response actions, personal air samples are collected on the following personnel: quality control, laborer, equipment operator, haul truck drivers, and TQA staff. Task-based air monitoring frequency for the project is summarized in Appendix B. Often times a removal task is shorter than the required sample duration. In these instances, a sample will not be collected.

4.4.2 Personal Air Sampling Methods

Personal air samples will be collected in accordance with OSHA Standard 29 CFR 1926.1101, Air Monitoring Frequencies (Appendix B), Sampling and Analysis (Appendix A) without modification. In general, personal air sampling will consist of collecting, at a minimum, one time-weighted average (TWA) sample and one short-term exposure limit (STEL) (i.e., one 30-minute excursion) sample per task. The overall intent of personal air sampling is to collect samples which are representative of an 8-hour workday. It may be necessary to collect multiple TWA samples for a task if it is believed the task will result in the overloading of filters from particulates.

Samples will be collected on a 25-mm, 0.8 MCE filter. Air sampling pumps will be calibrated before and after each sampling event in accordance with CDM-LIBBY-14, by use of a primary standard calibration device (e.g., Dry-Cal) or a properly calibrated secondary standard calibration device (e.g., rotameter). Other pertinent personal air sample collection procedures such as labeling, documentation, and custody are described in Section 4.9.

All personal air samples will be analyzed by PCM (NIOSH 1994a) with applicable project-specific laboratory modifications. If PCM results are above the TWA and or STEL action levels defined in 29 CFR 1926.1101, the sample will be analyzed by TEM AHERA (EPA 1987), with applicable project-specific laboratory modifications to determine if the fibers detected are asbestos structures.

4.4.3 Field QC Samples

The field QC samples associated with personal air samples are lot blanks and field blanks. These field QC samples will be collected and analyzed, and sample results evaluated in the same manner as perimeter air samples, which are discussed in Section 4.2.1.3 and summarized in Table 4-1.

4.5 Confirmation Soil Sampling

If a property requires removal of vermiculite-containing or LA-contaminated soil, confirmation soil samples will be collected following removal activities. Confirmation soil samples are collected to

determine if contaminated soils have been removed to project-specific clearance criteria. The site-specific removal work plan should be referenced to determine if any areas require soil excavation.

4.5.1 Confirmation Soil Sampling Rationale

Following the excavation of contaminated soils within the removal area and prior to confirmation soil sampling, a visual inspection for high concentrations of vermiculite in the excavated area and sidewalls will be performed. Since the presence of high levels of vermiculite is a likely indicator of LA, further excavation may be required prior to collecting confirmation soil samples. Results of the visual inspection will be compared to decision rules as described in Table 3-3. Once an excavation has been cleared through a visual inspection, a confirmation soil sample, including documentation of any remaining vermiculite observed within the sample area, will be collected to determine if cleanup goals have been achieved.

If additional soil excavation is required based on visual inspection, TQA staff will coordinate with the construction management team to discuss additional excavation area(s) and/or depth. TQA staff will delineate areas that require additional soil removal. If TQA staff determine the excavated surface are within project-specific limits, confirmation soil samples will be collected. If the excavation extends to the maximum excavation depth as described in the RAWP, an TQA staff member will collect confirmation soil samples at the maximum excavation depth for documentation purposes.

In order to facilitate removal activities progress, confirmation sampling may be conducted before final equipment decontamination of the contractor equipment (e.g., excavator, skid-steer, etc.). This is acceptable since the likelihood of introducing or increasing LA contamination within an excavation area with dedicated equipment within the exclusion zone is low.

Historical results for confirmation soil samples have shown few exceedances of project action levels at design depth. Therefore, to streamline restoration efforts, the removal contractor may initiate restoration in areas where confirmation soil samples were collected but results are not available. If the sample results indicate that any remaining contamination is within the acceptable limits, restoration can proceed as needed. However, if the sample results indicate that remaining contamination exceeds clearance criteria, the removal contractor will be directed to stop restoration activities and excavate any placed backfilled material and additional contaminated soils as outlined in Table 3-3.

If during an inspection, vermiculite is observed beyond the removal property boundary, details including depth, concentration (semi-quantitative), and location will be documented on the property closeout checklist (PCC) and the owner will be notified in their removal completion documents. Requirements for completing the PCC are discussed in the RAWP. It should be noted that unused, blank PCCs, as well as completed PCCs, will be maintained by A&E administrative staff at the A&E Libby project office in accordance with project data management requirements. Any substantial changes to the PCC will be discussed with and approved by the EPA and USACE prior to implementation.

4.5.1.1 Confirmation Soil Sampling Protocol for Removal of Municipal Alleyways, Driveways, and Parking Areas

Upon recognition of a municipal alleyway, driveway, or parking lot requiring a removal action, the design team will set up a meeting with the municipal representative and appropriate project

personnel prior to finalizing the site specific work plan to gather additional information needed to address the alleyway, roadway, or parking lot contamination in conjunction with the planned removal.

For municipal alleyways, driveways, and parking areas requiring removal action, the removal contractor will remove all soils to 6 inches bgs. Once the area has been excavated to 6 inches bgs, a visual inspection will be performed and documented by TQA personnel. In areas where high levels of vermiculite are observed at excavation depth, the area will be excavated to 12 inches bgs and re-inspected. In areas where intermediate or low levels of vermiculite are observed at 6 inches bgs, the area will be excavated until the vermiculite is no longer observable to a maximum depth of 12 inches bgs. In alleys with known buried utilities, all VV will be removed to the utility depth according to the steps described above. In the event an area has been excavated to 12 inches bgs (excluding areas with known buried utilities), TQA personnel will conduct an additional visual inspection. If VV is less than high at 12 inches, it will be documented by TQA personnel and a sample will be collected in accordance with the most recent version of the RA SAP. If visible contamination remains at high levels the removal contactor will excavate the area until the level of contamination is reduced or a maximum excavation depth of 3 feet bgs is reached. Appendix F shows the decision chart to be followed for the protocol for removal of municipal alleyways, driveways, and parking areas.

In the event that an area is excavated to less than 12 inches bgs, the area will not be backfilled until sample results have been reported back by the analytical laboratory as being "none detected" for LA. For areas extending to 12 inches bgs, standard clearance criteria for soil will apply.

The design depth for all public rights-of-way *leading into* alleyways, driveways, parking areas is 12 inches bgs. Standard clearance criteria for soil will apply.

Upon completion of the site specific work plan, the drafting team will schedule a follow up meeting and site walk with the municipality representative and Libby Asbestos Project personnel to review completed plans.

The decision chart should be followed for the confirmation soil sampling protocol for removal of municipal alleyways, driveways, and parking areas (Appendix D).

4.5.1.2 Confirmation Soil Sampling Protocol for Removal of Residential/Commercial Alleyways, Driveways, and Parking Areas

For private alleyways, driveways, and parking areas requiring removal actions under the Libby Asbestos Project, the removal contractor will remove all soils to 6 inches bgs. Once the area has been excavated to 6 inches bgs, a visual inspection will be performed by TQA personnel. If VV is less than high, it will be documented by TQA personnel and a sample will be collected in accordance with the most recent version of the RA SAP. If visible contamination remains at high levels the removal contactor will excavate the area until the level of contamination is reduced or a maximum of 3 feet bgs is reached.

The excavated area will be backfilled prior to receiving confirmation sample results. Libby project soil clearance criteria for the Libby Asbestos Project will be met. However, if the sample results indicate that remaining contamination exceeds clearance criteria, the removal contractor will be directed to stop restoration activities and excavate any placed backfilled material and additional contaminated soils as outlined in Table 3-3.

Design depth for all rights-of-way leading into alleyways, driveways, and parking areas will be 12 inches bgs and meet Libby project soil clearance criteria. The decision chart should be followed for the removal of residential/commercial alleyways, driveways, and parking areas (Appendix E).

4.5.2 Confirmation Soil Sampling Methods

Confirmation soil samples will be collected in accordance with CDM-LIBBY-13, 30-point Confirmation Soil Sampling (Appendix A). Each confirmation soil sample will be collected as a 30-point composite surface soil sample to characterize an area where contaminated soil has been removed and document any remaining vermiculite. Each sample will be collected from 0 to 2 inches below the surface of the completed excavation and consist of nearly equal portions of soil from 30 locations within the delineated sample area. Soils will be collected with a decontaminated trowel and should fill at least one-third of a 1-gallon plastic zipper-top bag. Homogenization of the samples will occur by mixing the sample inside the zipper-top bag. Considering removal contractor work progress, property features, and laboratory turnaround time limitations, it will be the discretion of TQA staff to decide the number of samples required to characterize the excavated area. However, to maintain consistency between the sampling team, at least one composite sample will be collected at a maximum of 2,500 square feet of excavation area. In the event that an area is excavated to maximum depth of 3 feet, the final confirmation soil sample will be collected and analyzed for informational purposes only. The excavation will not extend deeper than 3 feet.

Individual confirmation soil samples may include composite points from different use areas (e.g., yard and flowerbed, yard and garden) as long as all areas have been excavated to design depth and pass visual inspection. If an area cannot be excavated to design depth due to physical limitations, Section 4.5.2.2, Sampling for Areas Not Excavated to Design Depth, should be used to guide sampling.

4.5.2.1 Sampling During Excavation

Confirmation soil sampling may be performed simultaneously with the excavation of contaminated soils. That is, if the excavation is large enough, confirmation samples may be collected in areas of the excavation that are completed, while the removal contractor completes excavation in other areas. TQA staff will coordinate with the removal contractor prior to sampling to ensure future excavated work does not cross-contaminate sampled areas.

4.5.2.2 Sampling for Areas Not Excavated to Design Depth

Excavation along foundations, curbs and roads, sidewalks, and around trees presents many challenges for the removal contractor. Excavation along/adjacent to these areas may cause additional hazards such as structure failure, slope failure, and falling trees. Therefore, excavation in these areas may not advance to the depth specified in the site-specific removal work plan (i.e., design depth). These areas may be sampled separately or in combination with other similar areas as necessary. Although no additional excavation may be feasible, these samples will be collected for documentation purposes. Combining multiple areas not excavated to design depth as one sample will be acceptable in this instance. However, samples collected in these areas will be standalone (to be a more representative sample) and will not be combined with areas that have been excavated to design depth.

Excavation around trees will be completed in accordance with the RAWP and the site-specific removal work plan to the extent possible without sacrificing the integrity of the root system. If sampling is not feasible due to root congestion, a visual inspection for vermiculite, as outlined in SOP CDM-LIBBY-16, Semi-quantitative Visual Estimation of Vermiculite in Soils during Removal Activities (Appendix A), will be performed and quantities of vermiculite documented as low or intermediate. If high

concentrations of vermiculite are present, TQA staff will obtain approval from the government representative to allow excavation to continue.

4.5.2.3 Sampling Under Structures

If a structure (e.g., shed, deck, etc.) is moved during excavation and the footprint of the structure is less than 2,500 square feet, composite points of soil from the original structure's location can be combined with composite points of soil from the surrounding area to a maximum of 2,500 square feet for the combined areas. If a structure is not moved during excavation, a separate discreet soil sample will be collected from within the footprint of the structure, not to be combined with samples from the surrounding excavation area.

4.5.3 Field QC Samples

Two common field QC samples associated with soil sampling are equipment blanks and field duplicate samples. Equipment blanks are currently not required by the EPA for response action confirmation soil sampling because: 1) detection levels for LA using current polarized light microscopy (PLM) analytical methods are not low enough to capture concentrations that would be expected in equipment blanks; and 2) the frequency of detection for LA in historically-collected project equipment blanks is extremely low.

Field duplicate samples are generally collected if information regarding the variability of co-located soil samples is required. As part of the CSS (CDM 2002), field duplicates were collected in order to understand the variability observed in field duplicate samples in Libby soil. For this reason, and due to the need for expedited soil sample results, field duplicates are not required for the response action program.

4.6 Visible Vermiculite Point Inspections

During response actions at contaminated properties, it is EPA's goal to perform as thorough, consistent, and complete a clean up as within the criteria established in the governing guidance documents for the Libby Asbestos Site. The purpose of this section is to provide guidance to TQA staff to properly identify and delineate the extent of any VV observed in soils, via point inspections (PIs), in areas where soil excavations are not included in the original scope of work.

4.6.1 Visible Vermiculite Point Inspection Rationale

The GPI process includes standardized methods for inspecting surface soils for vermiculite, an indicator of LA. While every attempt is made to capture the lateral extent of vermiculite within property boundaries during investigation, it is possible that the observation of vermiculite in surface soils may be missed due to the heterogeneity and size of vermiculite within the soil matrix. Therefore, when a property undergoes response actions and the EPA/USACE contractors are mobilized to the site, a follow up inspection will be performed in an attempt to identify any remaining areas that contain vermiculite not identified on the removal design.

4.6.2 Visible Vermiculite Point Inspection Methods

All vermiculite inspections during removal activities will be conducted in accordance with SOP CDM-LIBBY-16 (Appendix A). PIs, as described in the SOP, will be used as the intrusive visual inspection method of inspecting and delineating the quantity and distribution of vermiculite not identified on the original design.

The follow up inspection will be performed by TQA staff with the assistance of sample technicians, as needed. If necessary, other qualified A&E staff may assist in the follow up inspections if suspect vermiculite is observed and not easily discernable. The follow up inspection activities will be focused on areas where the likelihood of observing vermiculite is greatest. These areas of interest include:

- Common-use areas (CUAs) and specific-use areas (SUAs), as defined in SOP CDM-Libby-16 (Appendix A), immediately adjacent to excavation boundaries (i.e., within 10 feet)
- Areas where new property information provided by the homeowner indicate vermiculite may be present
- Areas where property conditions have changed since previous investigation (e.g., imported soil, bare soil, removal of trailers, etc.)
- Areas with recent or planned activities that result in unearthed soil

It is imperative that the vermiculite PIs be performed as early as possible in the removal process to facilitate removal planning. Ideally the PI will be performed during setup activities but no later than when excavation crews leave the area of interest on a property. Further, PIs will be performed to coincide with the removal contractor's excavation plan and conducted in areas where the contractor will excavate first and advance to subsequent areas.

The process of performing a PI and estimating the presence of vermiculite is outlined in SOP CDM-LIBBY-16 (Appendix A). Prior to performing PIs, inspection zones will be established in areas of interest as described above. In general, inspection zones will be no larger than 100 square feet. Zones will be established based on site features and excavation boundaries and may not result in "perfect square" areas. Inspection zones will be established in CUAs and SUAs only as these areas are where additional excavation during removal activities may occur.

A PI consists of the active extraction and inspection of the ground surface; 0 to 3 inches in CUAs and 0 to 6 inches in SUAs. In some cases, the ground surface may limit how far inspections may advance (e.g., compacted driveways). The number of inspection points, or zones, will be dependent on how many areas of interest the field team will inspect.

For each zone, one PI will be performed in accordance with SOP CDM-LIBBY-16 (Appendix A). During PIs, field staff will estimate the quantity of vermiculite observed. Each PI will be assigned a semi-quantitative estimate of vermiculite content using a 4-point scale: none (N), low (L), intermediate (M), and high (H). A pin flag, or other field identifier, will be placed in areas where vermiculite was observed.

In general, the following decision rules will be followed when performing the vermiculite PIs:

- Zones where vermiculite is not observed will not be excavated
- Zones where one "low" observation (i.e., one flake) of vermiculite is recorded will be re-inspected by five additional follow up PIs. If vermiculite is not observed during the follow up PIs, the zone will not be excavated. If one "low" observation of vermiculite is recorded during the follow up PIs, perform five final PIs. If two or more flakes of vermiculite are recorded during follow up PIs, the area will be excavated. If during the final five PIs any vermiculite is observed,

the area will be excavated. If vermiculite is not observed during the final five PIs, the zone will not be excavated.

- Zones where two or more "low" observations (i.e., two or more flakes) of vermiculite will be excavated

If new zones are identified for excavation based on the process described above, a new zone will be established for inspection. This iterative process will continue until no new zones are identified for removal. TQA staff performing the PIs will work with the removal contractor to delineate the newly proposed excavation area, taking into consideration constructability issues as necessary. TQA staff will document the findings of the PIs and semi-quantify the observed VV on the provided investigation map as part of the site-specific work plan. This semi-quantifiable documentation will serve as justification for expanding the originally proposed excavation. This form of documentation will only be provided if the visible material found leads to further removal action. If the proposed expansion area is greater than 100 square feet, TQA staff will notifiy a USACE representative and the proposed expansion area will require USACE approval prior to moving forward. These activities will also be outlined in the daily QAR.

The additional removal area will also be demarcated on the field redline drawing and confirmation soil samples collected upon completion of removal. Documentation will be completed and submitted as part of the PCC upon completion of a final restoration inspection as outlined in the RAWP.

4.7 Potable Water Tank Testing

TQA staff and the removal contractor will use a standardized approach for testing potable water tanks at sites on the Libby Asbestos Project. The removal contractor will provide potable water throughout the duration of removal activities. Potable water may be tested by TQA staff and the removal contractor on a regular and frequent basis to ensure that it meets the standards as described under OSHA Standard 1910.141(b)(1)(i). The means for which water will be tested are listed below:

- Conduct a visual inspection of the potable water system to ensure proper setup and to select a test site
- Water will be drawn from the farthest point of tank possible (e.g., shower head, sink)
- Water source will be turned on and allowed to run for a minimum of two minutes prior to collecting sample
- TQA staff and the removal contractor will test for total chlorine (Cl_2) content in milligrams per cubic centimeter (mg/cc) by following the manufacturer's recommendations and procedures listed in the owner's manual for the particular test kit being used (e.g., Hach Pocket ColorimeterTM II or Hach Total Chlorine Test Strips)

4.8 Asbestos Water Sampling

Water samples will be collected from a variety of sources such as domestic water supplies (e.g., wells or indoor taps), area water bodies (e.g., rivers, creeks), or water sources associated with response action activities (e.g., equipment decontamination water, dust suppression, storage tank). These samples will be analyzed for asbestos as specified on the COC form accompanying the sample(s). Although there are no established frequencies for water samples, an A&E staff member will collect

samples as deemed necessary by government representatives affiliated with the Libby project or the A&E onsite health and safety officer, or as requested by the removal contractor. Water samples will be collected in approved, laboratory provided containers and submitted to the laboratory by the A&E sample coordinator within 48 hours of the collection time. Samples will be labeled and placed on ice prior to relinquishing them to the laboratory. Water samples will be documented, collected, and submitted using the same field processes as all other samples collected as part of this RA SAP (refer to Section 4.10). Water samples will be analyzed for asbestos using TEM ISO method 10312 (ISO 1995), as specified on the COC form. The standard turnaround time for water sample results shall be three business days, unless the COC form accompanying the samples sent to the laboratory indicates otherwise.

4.9 Asbestos Bulk Material Sampling

Bulk material samples may be collected for asbestos analysis from a variety of sources (e.g. log chinking, chimney mortar, plaster, or other building material) where vermiculite additives are visually identified, or a positive visual identification cannot be made. Prior to sample collection, the EPA or USACE representative shall authorize the activity. Upon authorization, a 3-point composite sample will be collected from each homogenous material as determined by the TQA. Bulk material samples will be collected and double bagged in 1-gallon zip-top bags, and submitted to the laboratory by the A&E sample coordinator within 24 hours of the collection time. Required volume for analysis will be specified by the laboratory prior to sample collection. Bulk material samples will be documented, collected, and submitted using the same documentation and custody processes as all other samples collected as part of this RA SAP (see Section 4.10). Bulk material samples will be analyzed by PLM using NIOSH 9002, Issue 2, *Asbestos (bulk) by PLM* (NIOSH 1994b), or as specified on the COC form. The standard turnaround time for bulk sample results shall be 24 hours, unless the COC form accompanying the samples sent to the laboratory indicates otherwise.

4.10 General Processes

This section describes the general field processes that will be used to support the sampling described in this RA SAP and includes references to the SOPs and project-specific procedures when applicable. If a sampling site becomes inaccessible for any reason (e.g. inclement weather, property owner refuses access, biological hazards, or other health and safety concerns), the USACE will be notified promptly in order to discuss a resolution or obtain a directive to proceed. All site accessibility issues, resolutions, and directives will be detailed in the field logbook and/or QAR, as appropriate.

4.10.1 Equipment Decontamination for Asbestos Field Soil Sampling

Equipment used to collect, handle, or measure soil and air samples being analyzed for asbestos only will be decontaminated before removing the equipment from any exclusion zone. Decontamination will be conducted in accordance with EPA-LIBBY-2012-04, Field Equipment Decontamination (Appendix A) with the following modifications:

Section 4.0, Required Equipment - Plastic sheeting will not be used during decontamination procedures. American Society for Testing and Materials Type II water will not be used. Rather, locally available de-ionized water will be used.

4.10.2 Investigation-derived Waste

IDW at each property will consist of excess sample volume, spent decontamination supplies, and PPE. All IDW will be handled in accordance with EPA-LIBBY-2012-05, Handling IDW (Appendix A).

4.10.3 Field Sample Data Sheets

The FSDS is a pre-numbered (i.e., controlled) record of specifics and will be completed for each sample and/or vermiculite inspection in accordance with SOP CDM-LIBBY-2012-03, FSDS Guidance (Appendix A). The FSDS number (located in the upper right-hand corner) will be referenced in the field logbook for each sample collected and/or each visual inspection performed. Completed FSDSs are used to directly enter information into the project database and to connect sample analysis results to the sample collected. Completed FSDSs (as well as unused FSDSs) will be maintained by A&E administrative staff at the Libby project office.

4.10.4 Field Logbooks

Documentation of field activities conducted under this RA SAP will be recorded in field logbooks maintained specifically for this sampling program. Field logbooks will be completed in accordance with EPA-LIBBY-2012-01, Field Logbook Content and Control (Appendix A). Logbooks are maintained by A&E administrative staff at the Libby project office and are assigned unique identification numbers (i.e., controlled) for reference on FSDSs.

A new logbook page will be completed for each property visited. The header information will include the address and Property ID (i.e., AD number). Field staff will also use the logbook to duly note problems or deviations from the governing plans and observations that may affect the quality or usability of the data being collected. When closing out a logbook page with lineout and signature, the author will also print his/her name underneath the signature. Upon completion of a logbook, A&E administrative staff will scan and electronically file the entire logbook. Completed hardcopy logbooks will be filed in numerical order in the A&E Libby project office.

4.10.5 Sample Labeling and Identification

A unique alphanumeric code, or sample ID, will identify each sample collected during response action sampling events. The coding system will provide a tracking record to allow retrieval of information about a particular sample and to ensure that each sample is uniquely identified. Sample IDs will be sequential and not be representative of any particular building or equipment. Sample IDs will correlate with sample location IDs, which will be identified on FSDSs and in the field logbooks.

The sample labeling scheme is as follows:

4R-XXXXX

Where:

4R identifies that a sample is collected in accordance with this RA SAP
XXXXX represents a 5-digit numeric code

Preprinted adhesive sample ID labels will be signed out to sampling personnel by a member of the A&E administration team using a sample ID logbook. The labels are controlled to prevent duplication in assigning sample IDs and prevent transcription errors in the documentation process. The labels will be affixed to both the sample cassette and sample bag for air samples, and both the inner and outer sample bags for soil samples. Sample ID labels will be used in accordance with EPA-LIBBY-06, Sample Custody.

4.10.6 Photographic Documentation

Photographs will be taken with a digital camera at any place that A&E field personnel determine necessary. Photographs will be taken in accordance with SOP EPA-LIBBY-2012-02, Photographic Documentation of Field Activities (Appendix A). Electronic photograph files will be saved each day to a project-designated server and named so that photographs for a particular property or activity (e.g., bulk insulation removal, interior dust removal, etc.) can easily be retrieved. The photograph file naming convention is as follows:

45 Montana Ave Attic Removal 05-21-13 (01)

Where:

45 Montana Ave = address where removal activities occurred
Attic = the location of activity being performed
Removal = the activity being documented
05-21-13 = the date the photo was taken
(01)= the number of the photo taken at that property that day

Following completion of removal activities, all photo files pertaining to a property will be copied onto a compact disc and filed in Libby along with other property-specific documentation.

4.10.7 Corrections to and Deviations from Governing Documents

Logbook entries will be completed in accordance with SOP EPA-LIBBY-2012-01, Field Logbook Content and Control (Appendix A). For the logbooks, a single strikeout initial and date is required for all changes. The correct information should be entered in close proximity to the erroneous entry. These procedures will also be followed for the correction of any field form.

All major deviations (i.e., those impacting or having the potential to impact data quality/usability) from this document will be recorded using the appropriate Libby Asbestos Project ROM Form[2]. Any minor deviations that do not impact project DQOs (e.g., air sample volumes that do not meet minimum volume requirements but do not require additional laboratory effort to achive target analytical sensitivity [AS]) will be documented in the logbook.

4.10.8 Field Sample Custody

Sample custody and documentation will follow the requirements specified in EPA-LIBBY-2012-06, Sample Custody (Appendix A), and project-specific guidance for the completion of FSDSs and production of COC forms per the EPA's project data requirements. All samples and FSDSs will be kept under strict custody and relinquished by A&E staff to the A&E sample coordinator or designated secure sample location at the end of each day. Upon completion of the FSDS by the sampler and a subsequent QC check by an independent field team member (i.e., not sample coordination staff), the sample coordinator will use the FSDS to generate a COC form. The COC form is employed as physical evidence of sample custody and control. This record system provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting. A completed COC form is required to accompany each shipment of samples. Three copies of the COC form will then

[2] The most recent version of the Soil Preparation Facility and Analytical Laboratory ROM Forms are available in the Libby Lab eRoom. Field ROM Forms are are available from the A&E Libby project QA coordinator.

be printed using three-part carbonless paper. One copy will be filed in the A&E Libby project office office and the other two will accompany sample shipments.

If samples are being transferred or shipped, the sample coordinator will verify that all samples are accounted for on the COC form and will hand-deliver or ship samples as appropriate. If any errors are found on the COC form after delivery/shipment, the hard copy maintained by the sample coordinator in Libby will be corrected by the sample coordinator with a single strikeout, initial, and date. The corrected copy will then be faxed or emailed to the laboratory coordinator and analytical laboratory and the information updated in all appropriate data management systems.

A&E administrative staff will be responsible for managing FSDSs after use by the sample coordinator, and the sample coordinator will maintain COC forms. All forms will be maintained at the A&E's Libby project office.

4.10.9 Sample Packaging and Shipping

Samples collected under this RA SAP and being analyzed for asbestos will be packaged and shipped (as shipping may apply) in accordance with EPA-LIBBY-2012-07, Packaging and Shipping of Environmental Samples (Appendix A).

Custody seals will be placed on each sample and on at least two sides of the shipping container (as shipping applies). All samples will be hand-delivered to the laboratory, picked up by a delivery service courier, or shipped by a delivery service to the designated laboratories, as necessary.

4.10.10 Field Equipment Maintenance

Air sampling pump calibrations will be conducted and documented in accordance with SOP EPA-LIBBY-2012-14, Stationary Air Sample Collection (Appendix A). Field equipment maintenance will be conducted and documented in accordance with SOP EPA-LIBBY-2012-03, Control of Measurement and Test Equipment (Appendix A). All calibration records will be maintained at the A&E's Libby project office.

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Section 5
Laboratory Operations

For this program, the EPA will be responsible for all sample analysis, including any sample processing prior to analysis. The A&E sample coordinator will be responsible for hand-delivering or shipping all samples per the designation of the laboratory coordinator. The A&E sample coordinator will also be responsible for communicating with the laboratory coordinator to relay pertinent sample and analysis information including sample quantities; special sample handling requirements, processing, or analysis concerns; and requested turnaround times.

This section discusses the analytical methods, custody and documentation procedures, quality assurance/quality control (QA/QC) requirements, and data management requirements to be employed by the laboratory in support of the Libby response action program.

5.1 Analytical Methods and Turnaround Times

This section describes the analytical methods used for response action samples.

An analytical summary sheet specific to sampling activities associated with this RA SAP (see Appendix C) will be distributed by the laboratory coordinator, and reviewed and approved by all participating laboratories prior to any sample handling.

All samples and grids will be maintained in storage at the analytical laboratory unless otherwise directed by the EPA. When authorized by the EPA, the laboratory will be responsible for proper disposal of any remaining samples, sample containers, shipping containers, and packing materials in accordance with sound environmental practice, based on the sample analytical results. The laboratory will maintain proper records of waste disposal methods, and will have disposal company contracts on file for inspection.

5.1.1 TEM AHERA – Stationary Air Samples

Perimeter and equipment monitoring air samples will be analyzed by TEM AHERA in accordance with 40 CFR Chapter 1, Part 763, Subpart E, Appendix A, *Interim Transmission Electron Microscopy Analytical Methods – Mandatory and Non-mandatory – and Mandatory Section to Determine Completion of Response Actions*. All project-specific laboratory modifications to the TEM AHERA method will be applied. The standard turnaround time for perimeter air sample results is one day unless otherwise requested on the COC.

The laboratory will attempt to achieve the method AS of 0.005 s/cc using direct sample preparation techniques and will employ project-specific stopping rules as documented in Laboratory Modification #LB-000017 unless other direction is provided. Users of the response action data should be aware that because of the project-specific stopping rule, reported sensitivities may be higher than the method AS. In the event that a perimeter air sample is determined to be overloaded by the analyst, the laboratory will contact either the A&E sample coordinator or FTL to report the issue (the laboratory coordinator will also be included in correspondence). When necessary, the analyst will proceed with analysis using the indirect sample preparation method, EPA-LIBBY-08 (EPA 2007).

5.1.2 TEM AHERA – Clearance Air Samples

As specified on the COC form, clearance air samples will be analyzed by TEM AHERA in accordance with 40 CFR Chapter 1, Part 763, Subpart E, Appendix A, *Interim Transmission Electron Microscopy Analytical Methods – Mandatory and Non-mandatory – and Mandatory Section to Determine Completion of Response Actions*. All project-specific laboratory modifications to the TEM AHERA method will be applied. The standard turnaround time for clearance air sample results is 1 day unless otherwise requested on the COC form.

The laboratory will achieve the method AS of 0.005 s/cc using direct sample preparation techniques. If the AS cannot be achieved, or any clearance air sample is deemed to be overloaded, the laboratory will contact the A&E sample coordinator or health and safety officer for further direction on how to proceed (e.g., to either proceed with analysis using the indirect sample preparation method using EPA-LIBBY-08 [EPA 2007] or cancel the analysis of the clearance sample set).

5.1.3 PCM – Personal Air Samples

Personal air samples will be analyzed by NIOSH 7400, Issue 2, *Asbestos and Other Fibers by PCM* (NIOSH 1994a), as specified on the COC form. All project-specific laboratory modifications to the PCM method will be applied. The standard turnaround time for personal air sample results is 1 day unless otherwise requested on the COC form.

The laboratory will attempt to achieve the level of detection specified by the analytical method (<0.01 f/cc) using direct sample preparation techniques but may employ project stopping rules as documented in Laboratory Modification LB-000015. Users of this response action data should be aware that because of the project-specific stopping rule, reported detection levels may be higher than the method detection level. In the event that a personal air sample is determined to be overloaded by the analyst according to the criteria described in Laboratory Modification LB-000015, the laboratory analyst will proceed with analysis using a standard PCM indirect sample preparation method.

5.1.4 TEM AHERA – Personal Air Samples

As previously discussed in Section 3, personal air PCM sample results that exceed the TWA and/or STEL action levels defined in 29 CFR 1926.1101 will be analyzed by the TEM AHERA method in accordance with 40 CFR Chapter 1, Part 763, Subpart E, Appendix A, *Interim Transmission Electron Microscopy Analytical Methods – Mandatory and Non-mandatory – and Mandatory Section to Determine Completion of Response Actions*, with project-specific modifications. This secondary analysis will identify if the fibers detected by PCM are asbestos structures. When TEM AHERA analyses are requested by the A&E health and safety officer or designate, the original COC form requesting PCM analysis will be revised by the A&E sample coordinator to include TEM AHERA analysis. The original COC form with markups and a revised electronic COC form printout will be faxed to the laboratory for their records. The standard turnaround time for these personal air sample results is 3 days unless otherwise requested on the COC form.

For personal air samples analyzed by TEM AHERA, the laboratory will attempt to achieve the method AS of 0.005 s/cc using direct sample preparation techniques and may employ project-specific stopping rules. Users of this response action data should be aware that because of the project-specific stopping rule, reported sensitivities may be higher than the method AS. In the event that a personal air sample is determined to be overloaded by the analyst, the laboratory will contact either the A&E sample coordinator or health and safety officer to report the issue (the laboratory coordinator will also be

notified of this correspondenc). When requested, the analyst will proceed with analysis using the indirect sample preparation method (EPA-LIBBY-08) (EPA 2007).

5.1.5 PLM – Confirmation Soil Samples

Confirmation soil samples will be analyzed by NIOSH 9002, Issue 2, *Asbestos (bulk) by PLM* (NIOSH 1994b), as specified on the COC form. All project-specific laboratory modifications to the NIOSH 9002 method will be applied. The standard turnaround time for confirmation soil sample results is 1 day unless otherwise requested on the COC form.

Because the method level of detection is estimated (at less than 1 percent asbestos), no specific level of detection has been established for project samples analyzed using NIOSH 9002.

Following receipt at the onsite analytical laboratory, confirmation soil samples will be thoroughly homogenized in accordance with project requirements then split. One sample split will be analyzed by the onsite laboratory and the other returned under strict custody to the laboratory coordinator for archive at the project sample storage facility in Libby.

5.1.6 TEM – Water Samples

Potable water will be analyzed by ISO Method 10312, *Determination of Asbestos Fibers by TEM* (ISO 1995), as specified on the COC form.

The standard turnaround time for water sample results is 3 business days unless otherwise requested on the COC form.

5.1.7 PLM – Bulk Material Samples

Bulk material samples collected as part of this effort will be analyzed by NIOSH 9002, Issue 2, *Asbestos (bulk) by PLM* (NIOSH 1994b), as specified on the COC form.

Because the level of detection is estimated (at less than 1 percent asbestos) for this method, no specific level of detection has been established for project samples analyzed using NIOSH 9002.

5.1.8 Field QC Samples

Air cassette lot blanks will be analyzed by both PCM and TEM AHERA (with applicable project-specific laboratory modifications) to the respective method analytical sensitivities. Lot blanks will be identified on the COC form so that the analytical laboratory is aware of their use and can immediately contact appropriate staff if asbestos fibers are detected on the filters.

Air field blanks will be analyzed by either PCM or TEM AHERA as specified on the COC form. Respective method analytical sensitivities will be achieved.

5.2 Holding Times

For the samples specified for collection in this RA SAP, no holding time requirements apply.

5.3 Laboratory Custody Procedures

Laboratory custody procedures are provided in the QA management plans for each laboratory. The basic laboratory sample custody process is as described herein. Upon receipt at the laboratory, each sample shipment will be inspected to assess the condition of the shipment and the individual samples. This inspection will include verifying sample integrity. The accompanying COC form will be cross-

referenced with all of the samples in the shipment. The laboratory sample custodian will sign the COC form and maintain a copy for their project files; the original COC form will be appended to the hard copy data report. Next, the sample custodian may assign a unique laboratory number to each sample on receipt. This number will identify the sample through all further handling at the laboratory. It is the laboratory's responsibility to maintain internal logbooks and records throughout sample preparation, analysis, data reporting, and sample archiving.

5.4 Laboratory QA/QC

The Libby Asbestos Project laboratory QA program consists of laboratory certifications, team training and mentoring, analyst training, and laboratory audits. Laboratories that analyze field samples on the Libby project must maintain particular certifications and must satisfactorily complete project-specific training requirements to ensure that proper QA/QC practices are conducted during sample analysis.

Analytical laboratories will be provided a copy of and will adhere to the requirements of this RA SAP. Samples collected under this RA SAP will be analyzed in accordance with standard EPA and/or nationally-recognized analytical procedures (i.e., Good Laboratory Practices) in order to provide analytical data of known quality and consistency.

5.5 Laboratory Documentation and Reporting

All deviations from project-specific and method analytical guidance documents, or this RA SAP, will be recorded on the Libby Asbestos Project Laboratory ROM Form (available in the Libby Lab eRoom). Any deviations that impact, or have the potential to impact, the DQOs of this RA SAP will be discussed with the OU4 EPA RPM, A&E site manager, and A&E FTL prior to implementation. In addition, the ROM Form will be used to document any information of interest as requested by the EPA. As modifications are approved by the EPA and implemented, the laboratory coordinator will communicate the changes to the project laboratories.

Sample results data will be delivered to the EPA to meet the requirements of the EPA's Libby data management plan.

5.6 Laboratory Nonconformance

Laboratories will immediately notify the laboratory coordinator if major problems occur (e.g., catastrophic equipment failure). The laboratory coordinator will then notify the A&E sample coordinator of potential impacts to turnaround times. Other nonconformance issues, such as those found during performance evaluations or audits, will be addressed on a case-by-case basis by the EPA's laboratory audit team.

Section 6

Assessments and Oversight

Assessments and oversight reports to management are necessary to ensure that procedures are followed as required and that deviations from procedures are documented. These reports also serve to keep management current on field activities. Assessment, oversight reports, and response actions are discussed below.

6.1 Assessments

Performance assessments are quantitative checks on the quality of a measurement system and are appropriate to analytical work. Performance assessments for the laboratories may be accomplished by submitting blind reference material (i.e., performance evaluation samples). These assessment samples are samples with known concentrations that are submitted to the laboratories without identifying them as such to the laboratories. Laboratory audits may be conducted upon request from the EPA RPM or USACE Project Manager.

System assessments (e.g., audits, surveillances) are qualitative reviews of different aspects of project work to check use of appropriate QC measures and the general function of the QA system. Project assessments will be performed for work conducted as part of this RA SAP under the direction of the A&E's QA Director, with support from A&E project QA staff that are independent of the field activities being conducted. Quality Procedure 6.2, as defined in the A&E's QA Manual (CDM Smith 2012), defines requirements for conducting system assessments. Due to the level and duration of response action field activities, annual field and bi-annual office audits may be anticipated.

6.2 Corrective Actions

Corrective actions will be implemented on a case-by-case basis to address quality problems. Minor actions taken in the field to immediately correct a quality problem will be documented in the applicable field logbook and a verbal report will be provided to the A&E Project Manager and/or Site Manager. Major corrective actions taken in the field will be approved by the EPA RPM, USACE Project Manager, and the A&E Project Manager prior to implementation of the change. Major response actions are those that may affect the quality or objective of the investigation. Quality problems that cannot be corrected quickly through routine procedures may require implementation of a corrective action request (CAR) form, as provided in the A&E's QA Manual (CDM Smith 2012).

All formal response actions will be submitted to either the A&E's QA Director or QA Coordinator for review and issuance. The A&E Project Manager or project QA Coordinator will notify their QA Director when quality problems arise that may require a formal response action. CAR forms will be completed according to Quality Procedure 8.1 of the A&E's QA Manual (CDM Smith 2012). In addition, when modifications to this RA SAP are required, either for field or laboratory activities, a Libby Asbestos Project ROM Form[3] must be completed and approved by the EPA.

[3] The most recent version of the Analytical Laboratory ROM Form is available in the Libby Lab eRoom. Field ROM Forms are are available from the A&E project Quality Assurance Manager.

6.3 Reports to Management

QA reports will be provided to management for routine audits and whenever quality problems are encountered. Field sampling staff will note any potential quality issues on QARs, FSDSs, or in field log notes as appropriate and bring the issue to the attention of their FTL or direct supervisor for necessary corrective action. Further, the A&E Project Manager will inform the project QA Coordinator upon encountering quality issues that cannot be immediately corrected. The project QA Coordinator will assist in documenting and resolving the quality issue.

Section 7

Data Validation and Usability

Key components to assessing the data collected as part of this RA SAP are: data review, data verification, data validation, and reconciliation with DQOs. This section outlines the general processes involved with each component.

7.1 Data Review and Verification

Data review (i.e., QC review) includes cross-checking that sample IDs and sample dates have been reported correctly on the preliminary laboratory report, and that calculated analytical sensitivities or detection levels are as expected. Once the preliminary results are received from the laboratory (typically via email), an A&E sample coordinator performs the preliminary data review and reports any discrepancies to the laboratory coordinator. The laboratory coordinator will coordinate with the laboratory to correct and reissue the results report.

Data verification includes checking that results have been transferred correctly from the original hand-written, hard copy field and analytical laboratory documentation to the project database. The goal of data verification is to identify and correct data reporting errors.

For analytical laboratories that utilize the project-specific EDD spreadsheets, data checking of reported analytical results begins with automated QC checks that have been built into the spreadsheets.

In addition to these automated checks, more detailed manual data verification efforts will be performed on a monthly basis for 10% of all analytical results uploaded to the project database in the preceding month. This data verification process utilizes site-specific SOPs[4] developed to ensure TEM and PLM results and field sample information in the project database are accurate and reliable:

- EPA-LIBBY-09 – *SOP for TEM Data Review and Data Entry Verification* – This site-specific SOP describes the steps for the verification of TEM analyses, based on a review of the laboratory benchsheets, and verification of the transfer of results from the benchsheets into the project database.
- EPA-LIBBY-10 - *SOP for PLM Data Review and Data Entry Verification* – This site-specific SOP describes the steps for the verification of PLM analyses, based on a review of the laboratory benchsheets, and verification of the transfer of results from the benchsheets into the project database.
- EPA-LIBBY-11 - *SOP for FSDS Data Review and Data Entry Verification* – This site-specific SOP describes the steps for the verification of field sample information, based on a review of the FSDS form, and verification of the transfer of results from the FSDS forms into the project database. An FSDS review is performed on all samples selected for TEM or PLM data verification.

[4] SOPs are available in the Libby Lab eRoom.

These regular data verification reviews will ensure that any data reporting issues are quickly identified and rectified to limit any impact on overall data quality. If issues are identified during the data verification, the frequency of these checks may be increased as appropriate.

Data verification will be performed by appropriate technical support staff that is familiar with project-specific data reporting, analytical methods, and investigation requirements. The data verifier will prepare a data verification report (template reports are included in the SOPs) to summarize any issues identified and necessary corrections. A copy of this report will be provided to the EPA data manager, laboratory coordinator, and the EPA RPM and USACE Project Manager. For data review related to data collected as part if the RA SAP, the data verifier will also complete and submit a Data Management Request form (the form is maintained in the Libby Lab eRoom), including any electronic files summarizing identified discrepancies, to the ESAT Team Manager for resolution. A follow-up email will be sent to the party reporting the issue to serve as confirmation that a resolution has been reached.

It is the responsibility of the ESAT Team Manager to coordinate with project data management staff to resolve any project database corrections and address any recommended field or laboratory procedural changes from the data verifier. The ESAT Team Manager is also responsible for electronically tracking in the project database which data have been verified and who performed the verification.

7.2 Data Validation

Unlike data verification, where the goal is to identify and correct data reporting errors, the goal of data validation is to evaluate overall data quality and to assign data qualifiers, as appropriate, to alert data users to any potential data quality issues. Data validation will be performed by the QATS contractor, with support from technical support staff that is familiar with project-specific data reporting, analytical methods, and investigation requirements.

Data validation for PCM, PLM, and TEM should be performed in basic accordance with the *National Functional Guidelines (NFG) for Asbestos Data Review* (EPA 2011), and should include an assessment of the following:

- Internal and external field audit/surveillance reports
- Field ROMs
- Field QC sample results
- Internal and external laboratory audit reports
- Laboratory contamination monitoring results
- Laboratory ROMs
- Internal laboratory QC analysis results (this includes all soil preparation, PCM, TEM, and PLM laboratory QC analysis results)
- Inter-laboratory analysis results
- Performance evaluation results

- Instrument checks and calibration results
- Data verification results (i.e., in the event that the verification effort identifies a larger data quality issue)

A comprehensive data validation effort should be completed quarterly and results should be reported as a technical memorandum. This technical memorandum shall detail the validation procedures performed and provide a narrative on the quality assessment for each type of analysis (PCM, PLM, TEM), including the data qualifiers assigned, and the reason(s) for these qualifiers. The technical memorandum shall detail any deficiencies and required corrective actions.

The QATS contractor will also prepare an annual addendum to the *Quality Assurance and Quality Control Summary Report for the Libby Asbestos Superfund Site* (CDM Smith 2011c) to summarize results of the quarterly data validation efforts. This addendum should include a summary of any data qualifiers that are to be added to the project database to denote when results do not meet NFG guidelines and/or project-specific acceptance criteria. This addendum should also include recommendations for Site QA/QC program changes to address any data quality issues. As appropriate, this QARD will be revised to incorporate these recommendations.

It is the responsibility of the ESAT Team Manager to ensure that the appropriate data qualifiers and reason codes recommended by the data validator are added to the project database, and to electronically track in the project database which data have been validated, who performed the validation, and when.

In addition to performing quarterly data validation efforts, it is the responsibility of the QATS contractor (or their designate) to perform a regular evaluation of all field blanks to ensure that any potential contamination issues are quickly identified and resolved. If any blank results are outside the acceptable limits (see Table 4-1), the QATS contractor should immediately contact the appropriate field Quality Assurance Manager to ensure that corrective actions are made.

7.3 DQO Reconciliation

The DQOs presented in Section 3 will be reconciled during the data review process, as outlined in Section 7.1. During this process, the A&E sample coordinator provides laboratory reports to TQA or A&E health and safety staff as appropriate, whereby the staff compare the sample results to the appropriate project-specific action levels discussed throughout this document. Attainment of project DQOs results in removal work progressing at specific residential and commercial properties, as discussed in the RAWP. Non-attainment of project DQOs will be immediately discussed with a USACE representative, as rework (e.g., additional attic cleaning followed by additional sampling) may be necessary in order to achieve DQOs.

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Section 8
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Appendix A

Standard Operating Procedures

Appendix A to Subpart E of Part 763 -- Interim Transmission Electron Microscopy Analytical Methods -- Mandatory and Nonmandatory -- and Mandatory Section to Determine Completion of Response Actions

I. Introduction

The following appendix contains three units. The first unit is the mandatory transmission electron microscopy (TEM) method which all laboratories must follow; it is the minimum requirement for analysis of air samples for asbestos by TEM. The mandatory method contains the essential elements of the TEM method. The second unit contains the complete non-mandatory method. The non-mandatory method supplements the mandatory method by including additional steps to improve the analysis. EPA recommends that the non-mandatory method be employed for analyzing air filters; however, the laboratory may choose to employ the mandatory method. The non-mandatory method contains the same minimum requirements as are outlined in the mandatory method. Hence, laboratories may choose either of the two methods for analyzing air samples by TEM.

The final unit of this Appendix A to subpart E defines the steps which must be taken to determine completion of response actions. This unit is mandatory.

II. Mandatory Transmission Electron Microscopy Method

A. Definitions of Terms

1. *Analytical sensitivity* -- Airborne asbestos concentration represented by each fiber counted under the electron microscope. It is determined by the air volume collected and the proportion of the filter examined. This method requires that the analytical sensitivity be no greater than 0.005 structures/cm ^{3}.

2. *Asbestiform* -- A specific type of mineral fibrosity in which the fibers and fibrils possess high tensile strength and flexibility.

3. *Aspect ratio* -- A ratio of the length to the width of a particle. Minimum aspect ratio as defined by this method is equal to or greater than 5:1.

4. *Bundle* -- A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

5. *Clean area* -- A controlled environment which is maintained and monitored to assure a low probability of asbestos contamination to materials in that space. Clean areas used in this method have HEPA filtered air under positive pressure and are capable of sustained operation with an open laboratory blank which on subsequent analysis has an average of less than 18 structures/mm ^{2} in an area of 0.057 mm ^{2} (nominally 10 200-mesh grid openings) and a maximum of 53 structures/mm ^{2} for any single preparation for that same area.

6. *Cluster* -- A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two

intersections.

7. *ED* -- Electron diffraction.

8. *EDXA* -- Energy dispersive X-ray analysis.

9. *Fiber* -- A structure greater than or equal to 0.5 µm in length with an aspect ratio (length to width) of 5:1 or greater and having substantially parallel sides.

10. *Grid* -- An open structure for mounting on the sample to aid in its examination in the TEM. The term is used here to denote a 200-mesh copper lattice approximately 3 mm in diameter.

11. *Intersection* -- Nonparallel touching or crossing of fibers, with the projection having an aspect ratio of 5:1 or greater.

12. *Laboratory sample coordinator* -- That person responsible for the conduct of sample handling and the certification of the testing procedures.

13. *Filter background level* -- The concentration of structures per square millimeter of filter that is considered indistinguishable from the concentration measured on a blank (filters through which no air has been drawn). For this method the filter background level is defined as 70 structures/mm ^{2}.

14. *Matrix* -- Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

15. *NSD* -- No structure detected.

16. *Operator* -- A person responsible for the TEM instrumental analysis of the sample.

17. *PCM* -- Phase contrast microscopy.

18. *SAED* -- Selected area electron diffraction.

19. *SEM* -- Scanning electron microscope.

20. *STEM* -- Scanning transmission electron microscope.

21. *Structure* -- a microscopic bundle, cluster, fiber, or matrix which may contain asbestos.

22. *S/cm 3* -- Structures per cubic centimeter.

23. *S/mm 2* -- Structures per square millimeter.

24. *TEM* -- Transmission electron microscope.

B. Sampling

1. The sampling agency must have written quality control procedures and documents which verify compliance.

2. Sampling operations must be performed by qualified individuals completely independent of the abatement contractor to avoid possible conflict of interest (References 1, 2, 3, and 5 of Unit II.J.).

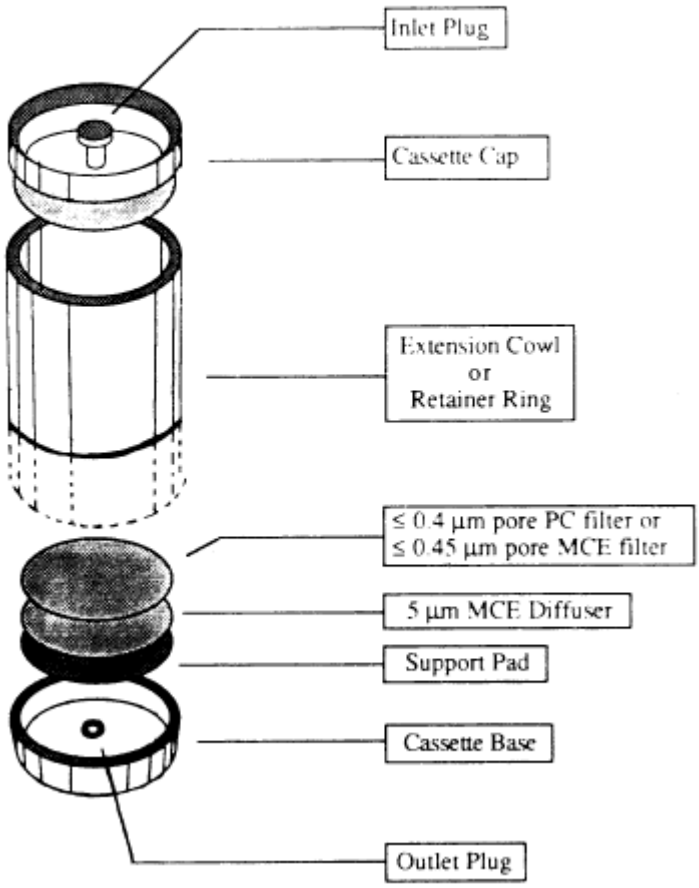
3. Sampling for airborne asbestos following an abatement action must use commercially available cassettes.

4. Prescreen the loaded cassette collection filters to assure that they do not contain concentrations of asbestos which may interfere with the analysis of the sample. A filter blank average of less than 18 s/mm ^{2} in an area of 0.057 mm ^{2} (nominally 10 200-mesh grid openings) and a single preparation with a maximum of 53 s/mm ^{2} for that same area is acceptable for this method.

5. Use sample collection filters which are either polycarbonate having a pore size less than or equal to 0.4 µm or mixed cellulose ester having a pore size less than or equal to 0.45 µm.

6. Place these filters in series with a 5.0 µm backup filter (to serve as a diffuser) and a support pad. See the following Figure 1:

FIGURE I--SAMPLING CASSETTE CONFIGURATION



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7. Reloading of used cassettes is not permitted.

8. Orient the cassette downward at approximately 45 degrees from the horizontal.

9. Maintain a log of all pertinent sampling information.

10. Calibrate sampling pumps and their flow indicators over the range of their intended use with a recognized standard. Assemble the sampling system with a representative filter (not the filter which will be used in sampling) before and after the sampling operation.

11. Record all calibration information.

12. Ensure that the mechanical vibrations from the pump will be minimized to prevent transferral of vibration to the cassette.

13. Ensure that a continuous smooth flow of negative pressure is delivered by the pump by damping out any pump action fluctuations if necessary.

14. The final plastic barrier around the abatement area remains in place for the sampling period.

15. After the area has passed a thorough visual inspection, use aggressive sampling conditions to dislodge any remaining dust. (See suggested protocol in Unit III.B.7.d.)

16. Select an appropriate flow rate equal to or greater than 1 liter per minute (L/min) or less than 10 L/min for 25 mm cassettes. Larger filters may be operated at proportionally higher flow rates.

17. A minimum of 13 samples are to be collected for each testing site consisting of the following:

a. A minimum of five samples per abatement area.

b. A minimum of five samples per ambient area positioned at locations representative of the air entering the abatement site.

c. Two field blanks are to be taken by removing the cap for not more than 30 seconds and replacing it at the time of sampling before sampling is initiated at the following places:

i. Near the entrance to each abatement area.

ii. At one of the ambient sites. (DO NOT leave the field blanks open during the sampling period.)

d. A sealed blank is to be carried with each sample set. This representative cassette is not to be opened in the field.

18. Perform a leak check of the sampling system at each indoor and outdoor sampling site by activating the pump with the closed sampling cassette in line. Any flow indicates a leak which must be eliminated before initiating the sampling operation.

19. The following Table I specifies volume ranges to be used:

TABLE 1--NUMBER OF 200 MESH EM GRID OPENINGS ($0.0057\ MM^2$) THAT NEED TO BE ANALYZED TO MAINTAIN SENSITIVITY OF 0.005 STRUCTURES/CC BASED ON VOLUME AND EFFECTIVE FILTER AREA

Effective Filter Area 385 sq mm		Effective Filter Area 855 sq mm	
Volume (liters)	# of grid openings	Volume (liters)	# of grid openings
560	*24*	*1,250*	*24*
600	23	1,300	23
700	19	1,400	21
800	17	1,600	19
900	15	1,800	17
1,000	14	2,000	15
1,100	12	2,200	14
1,200	**11**	2,400	13
1,300	**10**	2,600	12
1,400	**10**	**2,800**	**11**
1,500	**9**	**3,000**	**10**
1,600	**8**	**3,200**	**9**
1,700	**8**	**3,400**	**9**
1,800	**8**	**3,600**	**8**
1,900	7	**3,800**	**8**
2,000	7	**4,000**	**8**
2,100	6	4,200	7
2,200	6	4,400	7
2,300	6	4,600	7
2,400	6	4,800	6
2,500	5	5,000	6
2,600	5	5,200	6
2,700	5	5,400	6
2,800	5	5,600	5
2,900	5	5,800	5
3,000	5	6,000	5
3,100	4	6,200	5
3,200	4	6,400	5
3,300	4	6,600	5
3,400	4	6,800	4
3,500	4	7,000	4
3,600	4	7,200	4
3,700	4	7,400	4
3,800	4	7,600	4

Recommended Volume Range

Recommended Volume Range

Note minimum volumes required:
25 mm : 560 liters
37 mm : 1250 liters

Filter diameter of 25 mm = effective area of 385 sq mm
Filter diameter of 37 mm = effective area of 855 sq mm

20. Ensure that the sampler is turned upright before interrupting the pump flow.

21. Check that all samples are clearly labeled and that all pertinent information has been enclosed before transfer of the samples to the laboratory.

22. Ensure that the samples are stored in a secure and representative location.

23. Do not change containers if portions of these filters are taken for other purposes.

24. A summary of Sample Data Quality Objectives is shown in the following Table II:

TABLE II--SUMMARY OF SAMPLING AGENCY DATA QUALITY OBJECTIVES

This table summarizes the data quality objectives from the performance of this method in terms of precision, accuracy, completeness, representativeness, and comparability. These objectives are assured by the periodic control checks and reference checks listed here and described in the text of the method.

Unit Operation	QC Check	Frequency	Conformance Expectation
Sampling materials	Sealed blank	1 per I/O site	95%
Sample procedures	Field blanks	2 per I/O site	95%
	Pump calibration	Before and after each field series	90%
Sample custody	Review of chain-of-custody record	Each sample	95% complete
Sample shipment	Review of sending report	Each sample	95% complete

C. Sample Shipment

Ship bulk samples to the analytical laboratory in a separate container from air samples.

D. Sample Receiving

1. Designate one individual as sample coordinator at the laboratory. While that individual will normally be available to receive samples, the coordinator may train and supervise others in receiving procedures for those times when he/she is not available.

2. Bulk samples and air samples delivered to the analytical laboratory in the same container shall be rejected.

E. Sample Preparation

1. All sample preparation and analysis shall be performed by a laboratory independent of the abatement contractor.

2. Wet-wipe the exterior of the cassettes to minimize contamination possibilities before taking them into the clean room facility.

3. Perform sample preparation in a well-equipped clean facility.

>Note: The clean area is required to have the following minimum characteristics. The area or hood must be capable of maintaining a positive pressure with make-up air being HEPA-filtered. The cumulative analytical blank concentration must average less than 18 s/mm ^{2} in an area of 0.057 mm ^{2} (nominally 10 200-mesh grid openings) and a single preparation with a maximum of 53 s/mm ^{2} for that same area.

4. Preparation areas for air samples must not only be separated from preparation areas for bulk samples, but they must be prepared in separate rooms.

5. Direct preparation techniques are required. The object is to produce an intact film containing the particulates of the filter surface which is sufficiently clear for TEM analysis.

a. TEM Grid Opening Area measurement must be done as follows:

i. The filter portion being used for sample preparation must have the surface collapsed using an acetone vapor technique.

ii. Measure 20 grid openings on each of 20 random 200-mesh copper grids by placing a grid on a glass and examining it under the PCM. Use a calibrated graticule to measure the average field diameters. From the data, calculate the field area for an average grid opening.

iii. Measurements can also be made on the TEM at a properly calibrated low magnification or on an optical microscope at a magnification of approximately 400X by using an eyepiece fitted with a scale that has been calibrated against a stage micrometer. Optical microscopy utilizing manual or automated procedures may be used providing instrument calibration can be verified.

b. TEM specimen preparation from polycarbonate (PC) filters. Procedures as described in Unit III.G. or other equivalent methods may be used.

c. TEM specimen preparation from mixed cellulose ester (MCE) filters.

i. Filter portion being used for sample preparation must have the surface collapsed using an acetone vapor technique or the Burdette procedure (Ref. 7 of Unit II.J.)

ii. Plasma etching of the collapsed filter is required. The microscope slide to which the collapsed filter pieces are attached is placed in a plasma asher. Because plasma ashers vary greatly in their performance, both from unit to unit and between different positions in the asher chamber, it is difficult to specify the conditions that should be used. Insufficient etching will result in a failure to expose embedded filters, and too much etching may result in loss of particulate from the surface. As an interim measure, it is recommended that the time for ashing of a known weight of a collapsed filter be established and that the etching rate be calculated in terms of micrometers per second. The actual etching time used for the particulate asher and operating conditions will then be set such that a 1-2 μm (10 percent) layer of collapsed surface will be removed.

iii. Procedures as described in Unit III. or other equivalent methods may be used to prepare samples.

F. TEM Method

1. An 80-120 kV TEM capable of performing electron diffraction with a fluorescent screen inscribed with calibrated gradations is required. If the TEM is equipped with EDXA it must either have a STEM attachment or be capable of producing a spot less than 250 nm in diameter at crossover. The microscope shall be calibrated routinely for magnification and camera constant.

2. *Determination of Camera Constant and ED Pattern Analysis.* The camera length of the TEM in ED operating mode must be calibrated before ED patterns on unknown samples are observed. This can be achieved by using a carbon-coated grid on which a thin film of gold has been sputtered or evaporated. A thin film of gold is evaporated on the specimen TEM grid to obtain zone-axis ED patterns superimposed with a ring pattern from the polycrystalline gold film. In practice, it is desirable to optimize the thickness of the gold film so that only one or two sharp rings are obtained on the superimposed ED pattern. Thicker gold film would normally give multiple gold rings, but it will tend to mask weaker diffraction spots from the unknown fibrous particulate. Since the unknown d-spacings of most interest in asbestos analysis are those which lie closest to the transmitted beam, multiple gold rings are unnecessary on zone-axis ED patterns. An average camera constant using multiple gold rings can be determined. The camera constant is one-half the diameter of the rings times the interplanar spacing of the ring being measured.

3. *Magnification Calibration.* The magnification calibration must be done at the fluorescent screen. The TEM must be calibrated at the grid opening magnification (if used) and also at the magnification used for fiber counting. This is performed with a cross grating replica (e.g., one containing 2,160 lines/mm). Define a field of view on the fluorescent screen either by markings or physical boundaries. The field of view must be measurable or previously inscribed with a scale or concentric circles (all scales should be metric). A logbook must be maintained, and the dates of calibration and the values obtained must be recorded. The frequency of calibration depends on the past history of the particular microscope. After any maintenance of the microscope that involved adjustment of the power supplied to the lenses or the high-voltage system or the mechanical disassembly of the electron optical column apart from filament exchange, the magnification must be recalibrated. Before the TEM calibration is performed, the analyst must ensure that the cross grating replica is placed at the same distance from the objective lens as the specimens are. For instruments that incorporate a eucentric tilting specimen stage, all specimens and the cross grating replica must be placed at the eucentric position.

4. While not required on every microscope in the laboratory, the laboratory must have either one microscope equipped with energy dispersive X-ray analysis or access to an equivalent system on a TEM in another laboratory.

5. Microscope settings: 80-120 kV, grid assessment 250-1,000X, then 15,000-20,000X screen magnification for analysis.

6. Approximately one-half (0.5) of the predetermined sample area to be analyzed shall be performed on one sample grid preparation and the remaining half on a second sample grid preparation.

7. Individual grid openings with greater than 5 percent openings (holes) or covered with greater than 25 percent particulate matter or obviously having nonuniform loading must not be analyzed.

8. Reject the grid if:

a. Less than 50 percent of the grid openings covered by the replica are intact.

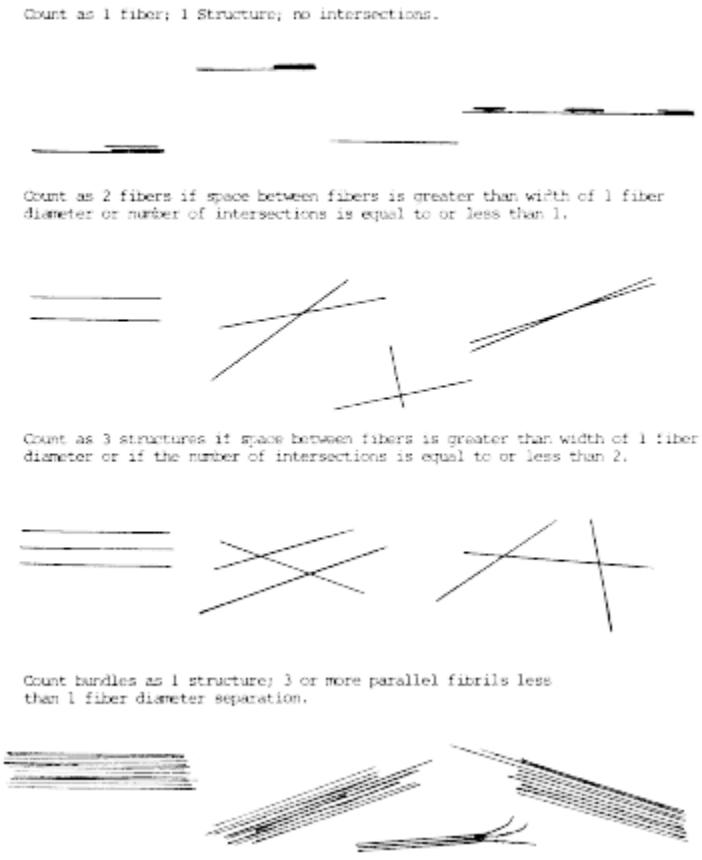
b. The replica is doubled or folded.

c. The replica is too dark because of incomplete dissolution of the filter.

9. *Recording Rules.*

a. Any continuous grouping of particles in which an asbestos fiber with an aspect ratio greater than or equal to 5:1 and a length greater than or equal to 0.5 µm is detected shall be recorded on the count sheet. These will be designated asbestos structures and will be classified as fibers, bundles, clusters, or matrices. Record as individual fibers any contiguous grouping having 0, 1, or 2 definable intersections. Groupings having more than 2 intersections are to be described as cluster or matrix. An intersection is a nonparallel touching or crossing of fibers, with the projection having an aspect ratio of 5:1 or greater. See the following Figure 2:

FIGURE 2--COUNTING GUIDELINES USED IN DETERMINING ASBESTOS STRUCTURES



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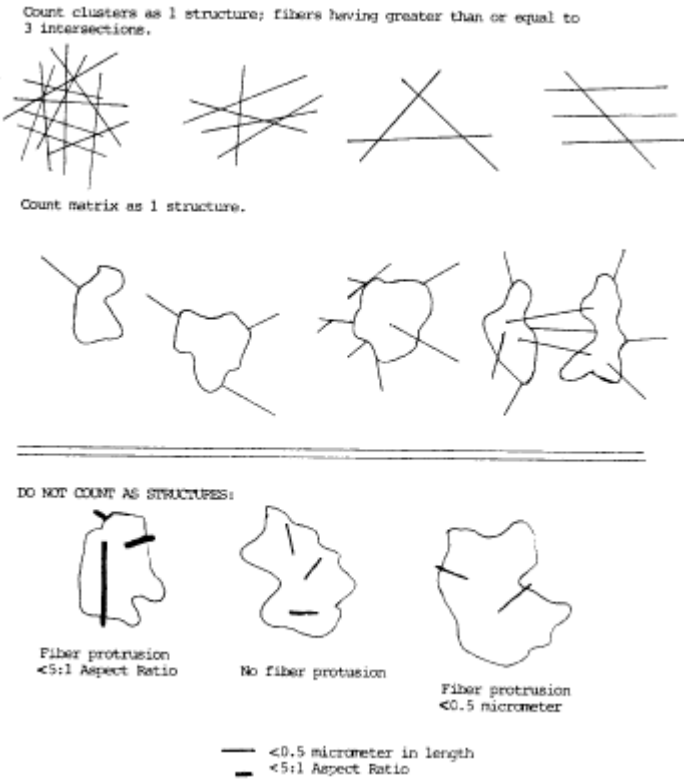

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i. *Fiber.* A structure having a minimum length greater than or equal to 0.5 µm and an aspect ratio (length to width) of 5:1 or greater and substantially parallel sides. Note the appearance of the end of the fiber, i.e., whether it is flat, rounded or dovetailed.

ii. *Bundle.* A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

iii. *Cluster.* A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections.

iv. *Matrix.* Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

b. Separate categories will be maintained for fibers less than 5 µm and for fibers equal to or greater than 5 µm in length.

c. Record NSD when no structures are detected in the field.

d. Visual identification of electron diffraction (ED) patterns is required for each asbestos structure counted which would cause the analysis to exceed the 70 s/mm ^{2} concentration. (Generally this means the first four fibers identified as asbestos must exhibit an identifiable diffraction pattern for chrysotile or amphibole.)

e. The micrograph number of the recorded diffraction patterns must be reported to the client and maintained in the laboratory's quality assurance records. In the event that examination of the pattern by a qualified individual indicates that the pattern has been misidentified visually, the client shall be contacted.

f. Energy Dispersive X-ray Analysis (EDXA) is required of all amphiboles which would cause the analysis results to exceed the 70 s/mm ^{2} concentration. (Generally speaking, the first 4

amphiboles would require EDXA.)

g. If the number of fibers in the nonasbestos class would cause the analysis to exceed the 70 s/mm ^{2} concentration, the fact that they are not asbestos must be confirmed by EDXA or measurement of a zone axis diffraction pattern.

h. Fibers classified as chrysotile must be identified by diffraction or X-ray analysis and recorded on a count sheet. X-ray analysis alone can be used only after 70 s/mm ^{2} have been exceeded for a particular sample.

i. Fibers classified as amphiboles must be identified by X-ray analysis and electron diffraction and recorded on the count sheet. (X-ray analysis alone can be used only after 70 s/mm ^{2} have been exceeded for a particular sample.)

j. If a diffraction pattern was recorded on film, record the micrograph number on the count sheet.

k. If an electron diffraction was attempted but no pattern was observed, record N on the count sheet.

l. If an EDXA spectrum was attempted but not observed, record N on the count sheet.

m. If an X-ray analysis spectrum is stored, record the file and disk number on the count sheet.

10. Classification Rules.

a. *Fiber.* A structure having a minimum length greater than or equal to 0.5 μm and an aspect ratio (length to width) of 5:1 or greater and substantially parallel sides. Note the appearance of the end of the fiber, i.e., whether it is flat, rounded or dovetailed.

b. *Bundle.* A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

c. *Cluster.* A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections.

d. *Matrix.* Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

11. After finishing with a grid, remove it from the microscope, and replace it in the appropriate grid holder. Sample grids must be stored for a minimum of 1 year from the date of the analysis; the sample cassette must be retained for a minimum of 30 days by the laboratory or returned at the client's request.

G. Sample Analytical Sequence

1. Under the present sampling requirements a minimum of 13 samples is to be collected for the clearance testing of an abatement site. These include five abatement area samples, five ambient samples, two field blanks, and one sealed blank.

2. Carry out visual inspection of work site prior to air monitoring.

3. Collect a minimum of 5 air samples inside the work site and 5 samples outside the work site. The indoor and outdoor samples shall be taken during the same time period.

4. Remaining steps in the analytical sequence are contained in Unit IV of this Appendix.

H. Reporting

1. The following information must be reported to the client for each sample analyzed:

a. Concentration in structures per square millimeter and structures per cubic centimeter.

b. Analytical sensitivity used for the analysis.

c. Number of asbestos structures.

d. Area analyzed.

e. Volume of air sampled (which must be initially supplied to lab by client).

f. Copy of the count sheet must be included with the report.

g. Signature of laboratory official to indicate that the laboratory met specifications of the method.

h. Report form must contain official laboratory identification (e.g., letterhead).

i. Type of asbestos.

I. Quality Control/Quality Assurance Procedures (Data Quality Indicators)

Monitoring the environment for airborne asbestos requires the use of sensitive sampling and analysis procedures. Because the test is sensitive, it may be influenced by a variety of factors. These include the supplies used in the sampling operation, the performance of the sampling, the preparation of the grid from the filter and the actual examination of this grid in the microscope. Each of these unit operations must produce a product of defined quality if the analytical result is to be a reliable and meaningful test result. Accordingly, a series of control checks and reference standards are to be performed along with the sample analysis as indicators that the materials used are adequate and the operations are within acceptable limits. In this way, the quality of the data is defined and the results are of known value. These checks and tests also provide timely and specific warning of any problems which might develop within the sampling and analysis operations. A description of these quality control/quality assurance procedures is summarized in the following Table III:

TABLE III--SUMMARY OF LABORATORY DATA QUALITY OBJECTIVES

Unit Operation	QC Check	Frequency	Conformance Expectation
Sample receiving	Review of receiving report	Each sample	95% complete
Sample custody	Review of chain-of-custody record	Each sample	95% complete
Sample preparation	Supplies and reagents	On receipt	Meet specs. or reject
	Grid opening size	20 openings/20 grids/lot of 1000 or 1 opening/sample	100%
	Special clean area monitoring	After cleaning or service	Meet specs or reclean
	Laboratory blank	1 per prep series or 10%	Meet specs. or reanalyze series
	Plasma etch blank	1 per 20 samples	75%
	Multiple preps (3 per sample)	Each sample	One with cover of 15 complete grid sqs.
Sample analysis	System check	Each day	Each day
	Alignment check	Each day	Each day
	Magnification calibration with low and high standards	Each month or after service	95%
	ED calibration by gold standard	Weekly	95%
	EDS calibration by copper line	Daily	95%
Performance check	Laboratory blank (measure of cleanliness)	Prep 1 per series or 10% read 1 per 25 samples	Meet specs or reanalyze series
	Replicate counting (measure of precision)	1 per 100 samples	1.5 x Poisson Std. Dev.
	Duplicate analysis (measure of reproducibility)	1 per 100 samples	2 x Poisson Std. Dev.
	Known samples of typical materials (working standards)	Training and for comparison with unknowns	100%
	Analysis of NBS SRM 1876 and/or RM 8410 (measure of accuracy and comparability)	1 per analyst per year	1.5 x Poisson Std. Dev.
	Data entry review (data validation and measure of completeness)	Each sample	95%
	Record and verify ID electron diffraction pattern of structure	1 per 5 samples	80% accuracy
Calculations and data reduction	Hand calculation of automated data reduction procedure or independent recalculation of hand-calculated data	1 per 100 samples	85%

1. When the samples arrive at the laboratory, check the samples and documentation for completeness and requirements before initiating the analysis.

2. Check all laboratory reagents and supplies for acceptable asbestos background levels.

3. Conduct all sample preparation in a clean room environment monitored by laboratory blanks. Testing with blanks must also be done after cleaning or servicing the room.

4. Prepare multiple grids of each sample.

5. Provide laboratory blanks with each sample batch. Maintain a cumulative average of these results. If there are more than 53 fibers/mm ^{2} per 10 200-mesh grid openings, the system must be checked for possible sources of contamination.

6. Perform a system check on the transmission electron microscope daily.

7. Make periodic performance checks of magnification, electron diffraction and energy dispersive X-ray systems as set forth in Table III under Unit II.I.

8. Ensure qualified operator performance by evaluation of replicate analysis and standard sample comparisons as set forth in Table III under Unit II.I.

9. Validate all data entries.

10. Recalculate a percentage of all computations and automatic data reduction steps as specified in Table III under Unit II.I.

11. Record an electron diffraction pattern of one asbestos structure from every five samples that contain asbestos. Verify the identification of the pattern by measurement or comparison of the pattern with patterns collected from standards under the same conditions. The records must also demonstrate that the identification of the pattern has been verified by a qualified individual and that the operator who made the identification is maintaining at least an 80 percent correct visual identification based on his measured patterns.

12. Appropriate logs or records must be maintained by the analytical laboratory verifying that it is in compliance with the mandatory quality assurance procedures.

J. References

For additional background information on this method, the following references should be consulted.

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11. "Guidance to the Preparation of Quality Assurance Project Plans," USEPA, Office of Pollution Prevention and Toxics, 1984.

III. Nonmandatory Transmission Electron Microscopy Method

A. Definitions of Terms

1. *Analytical sensitivity* -- Airborne asbestos concentration represented by each fiber counted under the electron microscope. It is determined by the air volume collected and the proportion of the filter examined. This method requires that the analytical sensitivity be no greater than 0.005 s/cm ^{3}.

2. *Asbestiform* -- A specific type of mineral fibrosity in which the fibers and fibrils possess high tensile strength and flexibility.

3. *Aspect ratio* -- A ratio of the length to the width of a particle. Minimum aspect ratio as defined by this method is equal to or greater than 5:1.

4. *Bundle* -- A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

5. *Clean area* -- A controlled environment which is maintained and monitored to assure a low probability of asbestos contamination to materials in that space. Clean areas used in this method have HEPA filtered air under positive pressure and are capable of sustained operation with an open laboratory blank which on subsequent analysis has an average of less than 18 structures/mm ^{2} in an area of 0.057 mm ^{2} (nominally 10 200 mesh grid openings) and a maximum of 53 structures/mm ^{2} for no more than one single preparation for that same area.

6. *Cluster* -- A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections.

7. *ED* -- Electron diffraction.

8. *EDXA* -- Energy dispersive X-ray analysis.

9. *Fiber* -- A structure greater than or equal to 0.5 μm in length with an aspect ratio (length to width) of 5:1 or greater and having substantially parallel sides.

10. *Grid* -- An open structure for mounting on the sample to aid in its examination in the TEM. The term is used here to denote a 200-mesh copper lattice approximately 3 mm in diameter.

11. *Intersection* -- Nonparallel touching or crossing of fibers, with the projection having an aspect ratio of 5:1 or greater.

12. *Laboratory sample coordinator* -- That person responsible for the conduct of sample handling and the certification of the testing procedures.

13. *Filter background level* -- The concentration of structures per square millimeter of filter that is considered indistinguishable from the concentration measured on blanks (filters through which no air has been drawn). For this method the filter background level is defined as 70 structures/mm ^{2}.

14. *Matrix* -- Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

15. *NSD* -- No structure detected.

16. *Operator* -- A person responsible for the TEM instrumental analysis of the sample.

17. *PCM* -- Phase contrast microscopy.

18. *SAED* -- Selected area electron diffraction.

19. *SEM* -- Scanning electron microscope.

20. *STEM* -- Scanning transmission electron microscope.

21. *Structure* -- a microscopic bundle, cluster, fiber, or matrix which may contain asbestos.

22. *S/cm 3* -- Structures per cubic centimeter.

23. *S/mm 2* -- Structures per square millimeter.

24. *TEM* -- Transmission electron microscope.

B. Sampling

1. Sampling operations must be performed by qualified individuals completely independent of the abatement contractor to avoid possible conflict of interest (See References 1, 2, and 5 of Unit III.L.) Special precautions should be taken to avoid contamination of the sample. For example, materials that have not been prescreened for their asbestos background content should not be used; also, sample handling procedures which do not take cross contamination possibilities into account should not be used.

2. Material and supply checks for asbestos contamination should be made on all critical supplies, reagents, and procedures before their use in a monitoring study.

3. Quality control and quality assurance steps are needed to identify problem areas and isolate the cause of the contamination (see Reference 5 of Unit III.L.). Control checks shall be permanently recorded to document the quality of the information produced. The sampling firm must have written quality control procedures and documents which verify compliance. Independent audits by a qualified consultant or firm should be performed once a year. All documentation of compliance should be retained indefinitely to provide a guarantee of quality. A summary of Sample Data Quality Objectives is shown in Table II of Unit II.B.

4. Sampling materials.

a. Sample for airborne asbestos following an abatement action using commercially available cassettes.

b. Use either a cowling or a filter-retaining middle piece. Conductive material may reduce the potential for particulates to adhere to the walls of the cowl.

c. Cassettes must be verified as "clean" prior to use in the field. If packaged filters are used for loading or preloaded cassettes are purchased from the manufacturer or a distributor, the manufacturer's name and lot number should be entered on all field data sheets provided to the laboratory, and are required to be listed on all reports from the laboratory.

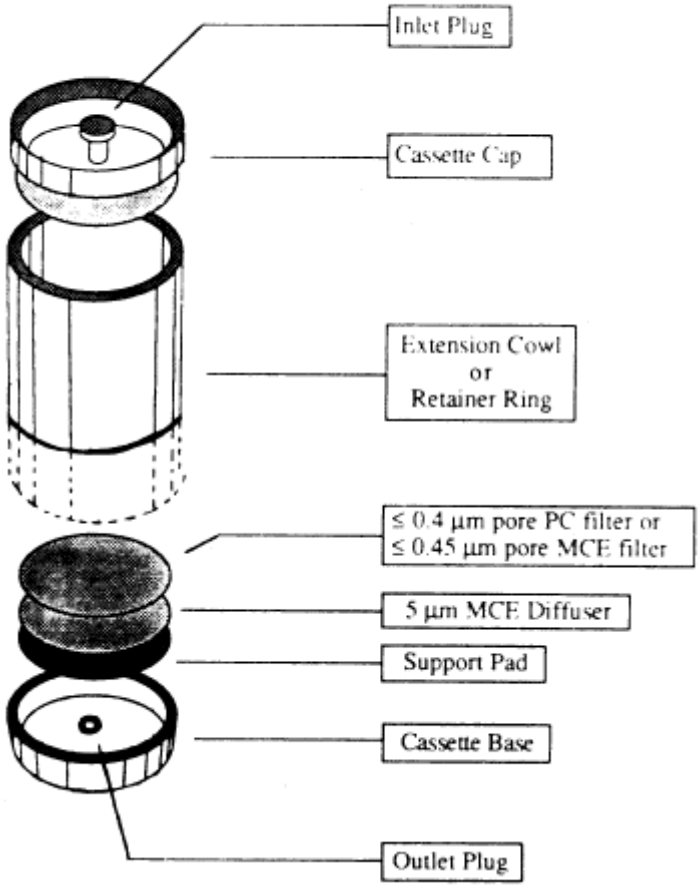
d. Assemble the cassettes in a clean facility (See definition of clean area under Unit III.A.).

e. Reloading of used cassettes is not permitted.

f. Use sample collection filters which are either polycarbonate having a pore size of less than or equal to 0.4 μm or mixed cellulose ester having a pore size of less than or equal to 0.45 μm.

g. Place these filters in series with a backup filter with a pore size of 5.0 μm (to serve as a diffuser) and a support pad. See the following Figure 1:

FIGURE I--SAMPLING CASSETTE CONFIGURATION



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h. When polycarbonate filters are used, position the highly reflective face such that the incoming particulate is received on this surface.

i. Seal the cassettes to prevent leakage around the filter edges or between cassette part joints. A mechanical press may be useful to achieve a reproducible leak-free seal. Shrink fit gel-bands may be used for this purpose and are available from filter manufacturers and their authorized distributors.

j. Use wrinkle-free loaded cassettes in the sampling operation.

5. Pump setup.

a. Calibrate the sampling pump over the range of flow rates and loads anticipated for the monitoring period with this flow measuring device in series. Perform this calibration using guidance from EPA Method 2A each time the unit is sent to the field (See Reference 6 of Unit III.L.).

b. Configure the sampling system to preclude pump vibrations from being transmitted to the cassette by using a sampling stand separate from the pump station and making connections with flexible tubing.

c. Maintain continuous smooth flow conditions by damping out any pump action fluctuations if necessary.

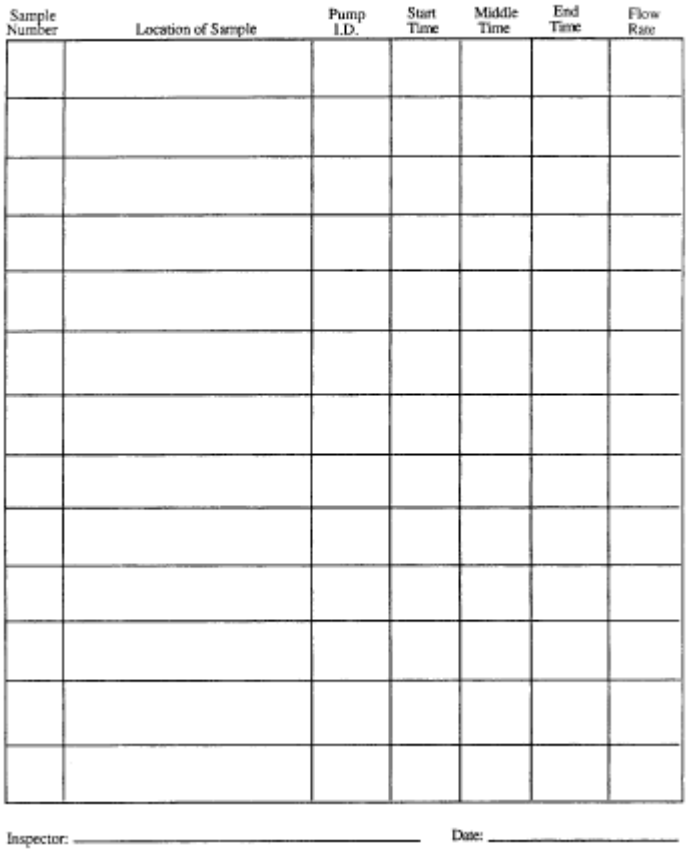
d. Check the sampling system for leaks with the end cap still in place and the pump operating before initiating sample collection. Trace and stop the source of any flow indicated by the flowmeter under these conditions.

e. Select an appropriate flow rate equal to or greater than 1 L/min or less than 10 L/min for 25 mm cassettes. Larger filters may be operated at proportionally higher flow rates.

f. Orient the cassette downward at approximately 45 degrees from the horizontal.

g. Maintain a log of all pertinent sampling information, such as pump identification number, calibration data, sample location, date, sample identification number, flow rates at the beginning, middle, and end, start and stop times, and other useful information or comments. Use of a sampling log form is recommended. See the following Figure 2:

FIGURE 2--SAMPLING LOG FORM



Sample Number	Location of Sample	Pump I.D.	Start Time	Middle Time	End Time	Flow Rate

Inspector: _____ Date: _____

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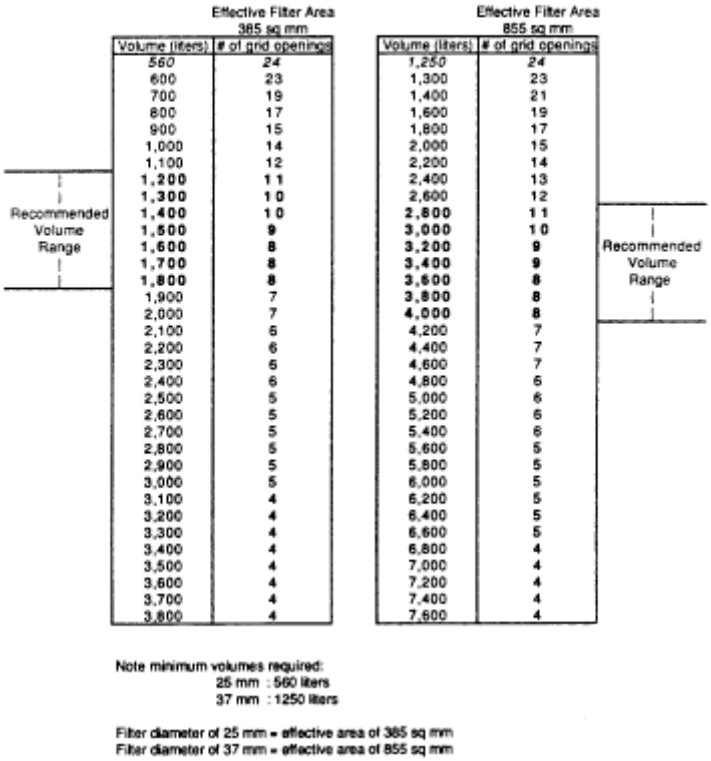
h. Initiate a chain of custody procedure at the start of each sampling, if this is requested by the client.

i. Maintain a close check of all aspects of the sampling operation on a regular basis.

j. Continue sampling until at least the minimum volume is collected, as specified in the following Table I:

TABLE 1--NUMBER OF 200 MESH EM GRID OPENINGS ($0.0057\ MM^2$) THAT NEED TO BE ANALYZED TO MAINTAIN SENSITIVITY OF 0.005 STRUCTURES/CC BASED ON VOLUME AND EFFECTIVE FILTER AREA



k. At the conclusion of sampling, turn the cassette upward before stopping the flow to minimize possible particle loss. If the sampling is resumed, restart the flow before reorienting the cassette downward. Note the condition of the filter at the conclusion of sampling.

l. Double check to see that all information has been recorded on the data collection forms and that the cassette is securely closed and appropriately identified using a waterproof label. Protect cassettes in individual clean resealed polyethylene bags. Bags are to be used for storing cassette caps when they are removed for sampling purposes. Caps and plugs should only be removed or replaced using clean hands or clean disposable plastic gloves.

m. Do not change containers if portions of these filters are taken for other purposes.

6. Minimum sample number per site. A minimum of 13 samples are to be collected for each testing consisting of the following:

a. A minimum of five samples per abatement area.

b. A minimum of five samples per ambient area positioned at locations representative of the air entering the abatement site.

c. Two field blanks are to be taken by removing the cap for not more than 30 sec and replacing it at the time of sampling before sampling is initiated at the following places:

i. Near the entrance to each ambient area.

ii. At one of the ambient sites.

(Note: Do not leave the blank open during the sampling period.)

d. A sealed blank is to be carried with each sample set. This representative cassette is not to be opened in the field.

7. Abatement area sampling.

a. Conduct final clearance sampling only after the primary containment barriers have been removed; the abatement area has been thoroughly dried; and, it has passed visual inspection tests by qualified personnel. (See Reference 1 of Unit III.L.)

b. Containment barriers over windows, doors, and air passageways must remain in place until the TEM clearance sampling and analysis is completed and results meet clearance test criteria. The final plastic barrier remains in place for the sampling period.

c. Select sampling sites in the abatement area on a random basis to provide unbiased and representative samples.

d. After the area has passed a thorough visual inspection, use aggressive sampling conditions to dislodge any remaining dust.

i. Equipment used in aggressive sampling such as a leaf blower and/or fan should be properly cleaned and decontaminated before use.

ii. Air filtration units shall remain on during the air monitoring period.

iii. Prior to air monitoring, floors, ceiling and walls shall be swept with the exhaust of a minimum one (1) horsepower leaf blower.

iv. Stationary fans are placed in locations which will not interfere with air monitoring equipment. Fan air is directed toward the ceiling. One fan shall be used for each 10,000 ft^3 of worksite.

v. Monitoring of an abatement work area with high-volume pumps and the use of circulating fans will require electrical power. Electrical outlets in the abatement area may be used if available. If no such outlets are available, the equipment must be supplied with electricity by the use of extension cords and strip plug units. All electrical power supply equipment of this type must be approved Underwriter Laboratory equipment that has not been modified. All wiring must be grounded. Ground fault interrupters should be used. Extreme care must be taken to clean up any residual water and ensure that electrical equipment does not become wet while operational.

vi. Low volume pumps may be carefully wrapped in 6-mil polyethylene to insulate the pump from the air. High volume pumps cannot be sealed in this manner since the heat of the motor may melt the plastic. The pump exhausts should be kept free.

vii. If recleaning is necessary, removal of this equipment from the work area must be handled with care. It is not possible to completely decontaminate the pump motor and parts since these areas cannot be wetted. To minimize any problems in this area, all equipment such as fans and pumps should be carefully wet wiped prior to removal from the abatement area. Wrapping and sealing low volume pumps in 6-mil polyethylene will provide easier decontamination of this equipment. Use of clean water and disposable wipes should be available for this purpose.

e. Pump flow rate equal to or greater than 1 L/min or less than 10 L/min may be used for 25 mm cassettes. The larger cassette diameters may have comparably increased flow.

f. Sample a volume of air sufficient to ensure the minimum quantitation limits. (See Table I of Unit III.B.5.j.)

8. Ambient sampling.

a. Position ambient samplers at locations representative of the air entering the abatement site. If makeup air entering the abatement site is drawn from another area of the building which is outside of the abatement area, place the pumps in the building, pumps should be placed out of

doors located near the building and away from any obstructions that may influence wind patterns. If construction is in progress immediately outside the enclosure, it may be necessary to select another ambient site. Samples should be representative of any air entering the work site.

b. Locate the ambient samplers at least 3 ft apart and protect them from adverse weather conditions.

c. Sample same volume of air as samples taken inside the abatement site.

C. Sample Shipment

1. Ship bulk samples in a separate container from air samples. Bulk samples and air samples delivered to the analytical laboratory in the same container shall be rejected.

2. Select a rigid shipping container and pack the cassettes upright in a noncontaminating nonfibrous medium such as a bubble pack. The use of resealable polyethylene bags may help to prevent jostling of individual cassettes.

3. Avoid using expanded polystyrene because of its static charge potential. Also avoid using particle-based packaging materials because of possible contamination.

4. Include a shipping bill and a detailed listing of samples shipped, their descriptions and all identifying numbers or marks, sampling data, shipper's name, and contact information. For each sample set, designate which are the ambient samples, which are the abatement area samples, which are the field blanks, and which is the sealed blank if sequential analysis is to be performed.

5. Hand-carry samples to the laboratory in an upright position if possible; otherwise choose that mode of transportation least likely to jar the samples in transit.

6. Address the package to the laboratory sample coordinator by name when known and alert him or her of the package description, shipment mode, and anticipated arrival as part of the chain of custody and sample tracking procedures. This will also help the laboratory schedule timely analysis for the samples when they are received.

D. Quality Control/Quality Assurance Procedures (Data Quality Indicators)

Monitoring the environment for airborne asbestos requires the use of sensitive sampling and analysis procedures. Because the test is sensitive, it may be influenced by a variety of factors. These include the supplies used in the sampling operation, the performance of the sampling, the preparation of the grid from the filter and the actual examination of this grid in the microscope. Each of these unit operations must produce a product of defined quality if the analytical result is to be a reliable and meaningful test result. Accordingly, a series of control checks and reference standards is performed along with the sample analysis as indicators that the materials used are adequate and the operations are within acceptable limits. In this way, the quality of the data is defined, and the results are of known value. These checks and tests also provide timely and specific warning of any problems which might develop within the sampling and analysis operations. A description of these quality control/quality assurance procedures is summarized in the text below.

1. Prescreen the loaded cassette collection filters to assure that they do not contain concentrations of asbestos which may interfere with the analysis of the sample. A filter blank average of less than 18 s/mm ^{2} in an area of 0.057 mm ^{2} (nominally 10 200-mesh grid openings) and a maximum of 53 s/mm ^{2} for that same area for any single preparation is acceptable for this method.

2. Calibrate sampling pumps and their flow indicators over the range of their intended use with a recognized standard. Assemble the sampling system with a representative filter -- not the filter which will be used in sampling -- before and after the sampling operation.

3. Record all calibration information with the data to be used on a standard sampling form.

4. Ensure that the samples are stored in a secure and representative location.

5. Ensure that mechanical calibrations from the pump will be minimized to prevent transferral of vibration to the cassette.

6. Ensure that a continuous smooth flow of negative pressure is delivered by the pump by installing a damping chamber if necessary.

7. Open a loaded cassette momentarily at one of the indoor sampling sites when sampling is initiated. This sample will serve as an indoor field blank.

8. Open a loaded cassette momentarily at one of the outdoor sampling sites when sampling is initiated. This sample will serve as an outdoor field blank.

9. Carry a sealed blank into the field with each sample series. Do not open this cassette in the field.

10. Perform a leak check of the sampling system at each indoor and outdoor sampling site by activating the pump with the closed sampling cassette in line. Any flow indicates a leak which must be eliminated before initiating the sampling operation.

11. Ensure that the sampler is turned upright before interrupting the pump flow.

12. Check that all samples are clearly labeled and that all pertinent information has been enclosed before transfer of the samples to the laboratory.

E. Sample Receiving

1. Designate one individual as sample coordinator at the laboratory. While that individual will normally be available to receive samples, the coordinator may train and supervise others in receiving procedures for those times when he/she is not available.

2. Adhere to the following procedures to ensure both the continued chain-of-custody and the accountability of all samples passing through the laboratory:

a. Note the condition of the shipping package and data written on it upon receipt.

b. Retain all bills of lading or shipping slips to document the shipper and delivery time.

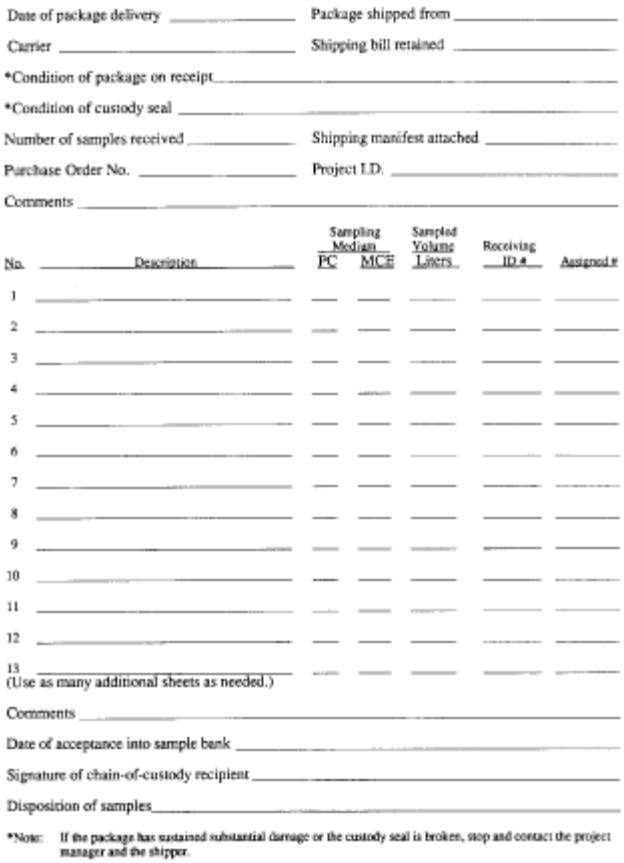
c. Examine the chain-of-custody seal, if any, and the package for its integrity.

d. If there has been a break in the seal or substantive damage to the package, the sample coordinator shall immediately notify the shipper and a responsible laboratory manager before any action is taken to unpack the shipment.

e. Packages with significant damage shall be accepted only by the responsible laboratory manager after discussions with the client.

3. Unwrap the shipment in a clean, uncluttered facility. The sample coordinator or his or her designee will record the contents, including a description of each item and all identifying numbers or marks. A Sample Receiving Form to document this information is attached for use when necessary. (See the following Figure 3.)

FIGURE 3--SAMPLE RECEIVING FORM



Date of package delivery _____ Package shipped from _____

Carrier _____ Shipping bill retained _____

*Condition of package on receipt _____

*Condition of custody seal _____

Number of samples received _____ Shipping manifest attached _____

Purchase Order No. _____ Project I.D. _____

Comments _____

No.	Description	Sampling Median PC	Sampling Median MCE	Sampled Volume Liters	Receiving ID #	Assigned #
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						

(Use as many additional sheets as needed.)

Comments _____

Date of acceptance into sample bank _____

Signature of chain-of-custody recipient _____

Disposition of samples _____

*Note: If the package has sustained substantial damage or the custody seal is broken, stop and contact the project manager and the shipper.

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Note: The person breaking the chain-of-custody seal and itemizing the contents assumes responsibility for the shipment and signs documents accordingly.

4. Assign a laboratory number and schedule an analysis sequence.

5. Manage all chain-of-custody samples within the laboratory such that their integrity can be ensured and documented.

F. Sample Preparation

1. Personnel not affiliated with the Abatement Contractor shall be used to prepare samples and conduct TEM analysis. Wet-wipe the exterior of the cassettes to minimize contamination possibilities before taking them to the clean sample preparation facility.

2. Perform sample preparation in a well-equipped clean facility.

Note: The clean area is required to have the following minimum characteristics. The area or hood must be capable of maintaining a positive pressure with make-up air being HEPA filtered. The cumulative analytical blank concentration must average less than 18 s/mm ^{2} in an area of 0.057 s/mm ^{2} (nominally 10 200-mesh grid openings) with no more than one single preparation to exceed 53 s/mm ^{2} for that same area.

3. Preparation areas for air samples must be separated from preparation areas for bulk samples. Personnel must not prepare air samples if they have previously been preparing bulk

samples without performing appropriate personal hygiene procedures, i.e., clothing change, showering, etc.

4. *Preparation.* Direct preparation techniques are required. The objective is to produce an intact carbon film containing the particulates from the filter surface which is sufficiently clear for TEM analysis. Currently recommended direct preparation procedures for polycarbonate (PC) and mixed cellulose ester (MCE) filters are described in Unit III.F.7. and 8. Sample preparation is a subject requiring additional research. Variation on those steps which do not substantively change the procedure, which improve filter clearing or which reduce contamination problems in a laboratory are permitted.

a. Use only TEM grids that have had grid opening areas measured according to directions in Unit III.J.

b. Remove the inlet and outlet plugs prior to opening the cassette to minimize any pressure differential that may be present.

c. Examples of techniques used to prepare polycarbonate filters are described in Unit III.F.7.

d. Examples of techniques used to prepare mixed cellulose ester filters are described in Unit III.F.8.

e. Prepare multiple grids for each sample.

f. Store the three grids to be measured in appropriately labeled grid holders or polyethylene capsules.

5. Equipment.

a. Clean area.

b. Tweezers. Fine-point tweezers for handling of filters and TEM grids.

c. Scalpel Holder and Curved No. 10 Surgical Blades.

d. Microscope slides.

e. Double-coated adhesive tape.

f. Gummed page reinforcements.

g. Micro-pipet with disposal tips 10 to 100 µL variable volume.

h. Vacuum coating unit with facilities for evaporation of carbon. Use of a liquid nitrogen cold trap above the diffusion pump will minimize the possibility of contamination of the filter surface by oil from the pumping system. The vacuum-coating unit can also be used for deposition of a thin film of gold.

i. *Carbon rod electrodes.* Spectrochemically pure carbon rods are required for use in the vacuum evaporator for carbon coating of filters.

j. *Carbon rod sharpener.* This is used to sharpen carbon rods to a neck. The use of necked carbon rods (or equivalent) allows the carbon to be applied to the filters with a minimum of heating.

k. *Low-temperature plasma asher.* This is used to etch the surface of collapsed mixed cellulose ester (MCE) filters. The asher should be supplied with oxygen, and should be modified as necessary to provide a throttle or bleed valve to control the speed of the vacuum to minimize

disturbance of the filter. Some early models of ashers admit air too rapidly, which may disturb particulates on the surface of the filter during the etching step.

l. *Glass petri dishes, 10 cm in diameter, 1 cm high.* For prevention of excessive evaporation of solvent when these are in use, a good seal must be provided between the base and the lid. The seal can be improved by grinding the base and lid together with an abrasive grinding material.

m. Stainless steel mesh.

n. Lens tissue.

o. Copper 200-mesh TEM grids, 3 mm in diameter, or equivalent.

p. Gold 200-mesh TEM grids, 3 mm in diameter, or equivalent.

q. Condensation washer.

r. Carbon-coated, 200-mesh TEM grids, or equivalent.

s. Analytical balance, 0.1 mg sensitivity.

t. Filter paper, 9 cm in diameter.

u. Oven or slide warmer. Must be capable of maintaining a temperature of 65-70 °C.

v. Polyurethane foam, 6 mm thickness.

w. Gold wire for evaporation.

6. Reagents.

a. *General.* A supply of ultra-clean, fiber-free water must be available for washing of all components used in the analysis. Water that has been distilled in glass or filtered or deionized water is satisfactory for this purpose. Reagents must be fiber-free.

b. Polycarbonate preparation method -- chloroform.

c. Mixed Cellulose Ester (MCE) preparation method -- acetone or the Burdette procedure (Ref. 7 of Unit III.L.).

7. TEM specimen preparation from polycarbonate filters.

a. *Specimen preparation laboratory.* It is most important to ensure that contamination of TEM specimens by extraneous asbestos fibers is minimized during preparation.

b. Cleaning of sample cassettes. Upon receipt at the analytical laboratory and before they are taken into the clean facility or laminar flow hood, the sample cassettes must be cleaned of any contamination adhering to the outside surfaces.

c. Preparation of the carbon evaporator. If the polycarbonate filter has already been carbon-coated prior to receipt, the carbon coating step will be omitted, unless the analyst believes the carbon film is too thin. If there is a need to apply more carbon, the filter will be treated in the same way as an uncoated filter. Carbon coating must be performed with a high-vacuum coating unit. Units that are based on evaporation of carbon filaments in a vacuum generated only by an oil rotary pump have not been evaluated for this application, and must not be used. The carbon rods should be sharpened by a carbon rod sharpener to necks of about 4 mm long and 1 mm in diameter. The rods are installed in the evaporator in such a manner that the points are approximately 10 to 12 cm from the surface of a microscope slide held in the rotating and

tilting device.

d. Selection of filter area for carbon coating. Before preparation of the filters, a 75 mm×50 mm microscope slide is washed and dried. This slide is used to support strips of filter during the carbon evaporation. Two parallel strips of double-sided adhesive tape are applied along the length of the slide. Polycarbonate filters are easily stretched during handling, and cutting of areas for further preparation must be performed with great care. The filter and the MCE backing filter are removed together from the cassette and placed on a cleaned glass microscope slide. The filter can be cut with a curved scalpel blade by rocking the blade from the point placed in contact with the filter. The process can be repeated to cut a strip approximately 3 mm wide across the diameter of the filter. The strip of polycarbonate filter is separated from the corresponding strip of backing filter and carefully placed so that it bridges the gap between the adhesive tape strips on the microscope slide. The filter strip can be held with fine-point tweezers and supported underneath by the scalpel blade during placement on the microscope slide. The analyst can place several such strips on the same microscope slide, taking care to rinse and wet-wipe the scalpel blade and tweezers before handling a new sample. The filter strips should be identified by etching the glass slide or marking the slide using a marker insoluble in water and solvents. After the filter strip has been cut from each filter, the residual parts of the filter must be returned to the cassette and held in position by reassembly of the cassette. The cassette will then be archived for a period of 30 days or returned to the client upon request.

e. Carbon coating of filter strips. The glass slide holding the filter strips is placed on the rotation-tilting device, and the evaporator chamber is evacuated. The evaporation must be performed in very short bursts, separated by some seconds to allow the electrodes to cool. If evaporation is too rapid, the strips of polycarbonate filter will begin to curl, which will lead to cross-linking of the surface material and make it relatively insoluble in chloroform. An experienced analyst can judge the thickness of carbon film to be applied, and some test should be made first on unused filters. If the film is too thin, large particles will be lost from the TEM specimen, and there will be few complete and undamaged grid openings on the specimen. If the coating is too thick, the filter will tend to curl when exposed to chloroform vapor and the carbon film may not adhere to the support mesh. Too thick a carbon film will also lead to a TEM image that is lacking in contrast, and the ability to obtain ED patterns will be compromised. The carbon film should be as thin as possible and remain intact on most of the grid openings of the TEM specimen intact.

f. Preparation of the Jaffe washer. The precise design of the Jaffe washer is not considered important, so any one of the published designs may be used. A washer consisting of a simple stainless steel bridge is recommended. Several pieces of lens tissue approximately 1.0 cm×0.5 cm are placed on the stainless steel bridge, and the washer is filled with chloroform to a level where the meniscus contacts the underside of the mesh, which results in saturation of the lens tissue. See References 8 and 10 of Unit III.L.

g. Placing of specimens into the Jaffe washer. The TEM grids are first placed on a piece of lens tissue so that individual grids can be picked up with tweezers. Using a curved scalpel blade, the analyst excises three 3 mm square pieces of the carbon-coated polycarbonate filter from the filter strip. The three squares are selected from the center of the strip and from two points between the outer periphery of the active surface and the center. The piece of filter is placed on a TEM specimen grid with the shiny side of the TEM grid facing upwards, and the whole assembly is placed boldly onto the saturated lens tissue in the Jaffe washer. If carbon-coated grids are used, the filter should be placed carbon-coated side down. The three excised squares of filters are placed on the same piece of lens tissue. Any number of separate pieces of lens tissue may be placed in the same Jaffe washer. The lid is then placed on the Jaffe washer, and the system is allowed to stand for several hours, preferably overnight.

h. *Condensation washing.* It has been found that many polycarbonate filters will not dissolve completely in the Jaffe washer, even after being exposed to chloroform for as long as 3 days. This problem becomes more serious if the surface of the filter was overheated during the carbon evaporation. The presence of undissolved filter medium on the TEM preparation leads to partial or complete obscuration of areas of the sample, and fibers that may be present in these areas of the specimen will be overlooked; this will lead to a low result. Undissolved filter

medium also compromises the ability to obtain ED patterns. Before they are counted, TEM grids must be examined critically to determine whether they are adequately cleared of residual filter medium. It has been found that condensation washing of the grids after the initial Jaffe washer treatment, with chloroform as the solvent, clears all residual filter medium in a period of approximately 1 hour. In practice, the piece of lens tissue supporting the specimen grids is transferred to the cold finger of the condensation washer, and the washer is operated for about 1 hour. If the specimens are cleared satisfactorily by the Jaffe washer alone, the condensation washer step may be unnecessary.

8. TEM specimen preparation from MCE filters.

a. This method of preparing TEM specimens from MCE filters is similar to that specified in NIOSH Method 7402. See References 7, 8, and 9 of Unit III.L.

b. Upon receipt at the analytical laboratory, the sample cassettes must be cleaned of any contamination adhering to the outside surfaces before entering the clean sample preparation area.

c. Remove a section from any quadrant of the sample and blank filters.

d. Place the section on a clean microscope slide. Affix the filter section to the slide with a gummed paged reinforcement or other suitable means. Label the slide with a water and solvent-proof marking pen.

e. Place the slide in a petri dish which contains several paper filters soaked with 2 to 3 mL acetone. Cover the dish. Wait 2 to 4 minutes for the sample filter to fuse and clear.

f. Plasma etching of the collapsed filter is required.

i. The microscope slide to which the collapsed filter pieces are attached is placed in a plasma asher. Because plasma ashers vary greatly in their performance, both from unit to unit and between different positions in the asher chamber, it is difficult to specify the conditions that should be used. This is one area of the method that requires further evaluation. Insufficient etching will result in a failure to expose embedded filters, and too much etching may result in loss of particulate from the surface. As an interim measure, it is recommended that the time for ashing of a known weight of a collapsed filter be established and that the etching rate be calculated in terms of micrometers per second. The actual etching time used for a particular asher and operating conditions will then be set such that a 1-2 μm (10 percent) layer of collapsed surface will be removed.

ii. Place the slide containing the collapsed filters into a low-temperature plasma asher, and etch the filter.

g. Transfer the slide to a rotating stage inside the bell jar of a vacuum evaporator. Evaporate a 1 mm×5 mm section of graphite rod onto the cleared filter. Remove the slide to a clean, dry, covered petri dish.

h. Prepare a second petri dish as a Jaffe washer with the wicking substrate prepared from filter or lens paper placed on top of a 6 mm thick disk of clean spongy polyurethane foam. Cut a V-notch on the edge of the foam and filter paper. Use the V-notch as a reservoir for adding solvent. The wicking substrate should be thin enough to fit into the petri dish without touching the lid.

i. Place carbon-coated TEM grids face up on the filter or lens paper. Label the grids by marking with a pencil on the filter paper or by putting registration marks on the petri dish lid and marking with a waterproof marker on the dish lid. In a fume hood, fill the dish with acetone until the wicking substrate is saturated. The level of acetone should be just high enough to saturate the filter paper without creating puddles.

j. Remove about a quarter section of the carbon-coated filter samples from the glass slides using a surgical knife and tweezers. Carefully place the section of the filter, carbon side down, on the appropriately labeled grid in the acetone-saturated petri dish. When all filter sections have been transferred, slowly add more solvent to the wedge-shaped trough to bring the acetone level up to the highest possible level without disturbing the sample preparations. Cover the petri dish. Elevate one side of the petri dish by placing a slide under it. This allows drops of condensed solvent vapors to form near the edge rather than in the center where they would drip onto the grid preparation.

G. TEM Method

1. *Instrumentation.*

a. Use an 80-120 kV TEM capable of performing electron diffraction with a fluorescent screen inscribed with calibrated gradations. If the TEM is equipped with EDXA it must either have a STEM attachment or be capable of producing a spot less than 250 nm in diameter at crossover. The microscope shall be calibrated routinely (see Unit III.J.) for magnification and camera constant.

b. While not required on every microscope in the laboratory, the laboratory must have either one microscope equipped with energy dispersive X-ray analysis or access to an equivalent system on a TEM in another laboratory. This must be an Energy Dispersive X-ray Detector mounted on TEM column and associated hardware/software to collect, save, and read out spectral information. Calibration of Multi-Channel Analyzer shall be checked regularly for A1 at 1.48 KeV and Cu at 8.04 KeV, as well as the manufacturer's procedures.

i. Standard replica grating may be used to determine magnification (e.g., 2160 lines/mm).

ii. Gold standard may be used to determine camera constant.

c. Use a specimen holder with single tilt and/or double tilt capabilities.

2. Procedure.

a. Start a new Count Sheet for each sample to be analyzed. Record on count sheet: analyst's initials and date; lab sample number; client sample number microscope identification; magnification for analysis; number of predetermined grid openings to be analyzed; and grid identification. See the following Figure 4:

FIGURE 4--COUNT SHEET

Lab Sample No. _____ Filter Type _____ Operator _____
Client Sample No. _____ Filter Area _____ Date _____
Instrument I.D. _____ Grid I.D. _____ Comments _____
Magnification _____ Grid Opening (GO) Area _____ _____
Acc. Voltage _____ No. GO to be Analyzed _____ _____

GO	Structure No.	Structure Type*	Length		ED Observation				EDAX
			< 5µm	≥ 5 µm	Chrys.	Amph.	Nonasb.	Neg. ID	

GO	Structure No.	Structure Type*	Length		ED Observation				EDAX
			< 5µm	≥ 5 µm	Chrys.	Amph.	Nonasb.	Neg. ID	

*B = Bundle
C = Cluster
F = Fiber
M = Matrix

NFD = No fibers detected
N = No diffraction obtained

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b. Check that the microscope is properly aligned and calibrated according to the manufacturer's specifications and instructions.

c. Microscope settings: 80-120 kV, grid assessment 250-1000X, then 15,000-20,000X screen magnification for analysis.

d. Approximately one-half (0.5) of the predetermined sample area to be analyzed shall be performed on one sample grid preparation and the remaining half on a second sample grid preparation.

e. Determine the suitability of the grid.

i. Individual grid openings with greater than 5 percent openings (holes) or covered with greater than 25 percent particulate matter or obviously having nonuniform loading shall not be analyzed.

ii. Examine the grid at low magnification (<1000X) to determine its suitability for detailed study at higher magnifications.

iii. Reject the grid if:

(1) Less than 50 percent of the grid openings covered by the replica are intact.

(2) It is doubled or folded.

(3) It is too dark because of incomplete dissolution of the filter.

iv. If the grid is rejected, load the next sample grid.

v. If the grid is acceptable, continue on to Step 6 if mapping is to be used; otherwise proceed to Step 7.

f. Grid Map (Optional).

i. Set the TEM to the low magnification mode.

ii. Use flat edge or finder grids for mapping.

iii. Index the grid openings (fields) to be counted by marking the acceptable fields for one-half (0.5) of the area needed for analysis on each of the two grids to be analyzed. These may be marked just before examining each grid opening (field), if desired.

iv. Draw in any details which will allow the grid to be properly oriented if it is reloaded into the microscope and a particular field is to be reliably identified.

g. Scan the grid.

i. Select a field to start the examination.

ii. Choose the appropriate magnification (15,000 to 20,000X screen magnification).

iii. Scan the grid as follows.

(1) At the selected magnification, make a series of parallel traverses across the field. On reaching the end of one traverse, move the image one window and reverse the traverse.

Note: A slight overlap should be used so as not to miss any part of the grid opening (field).

(2) Make parallel traverses until the entire grid opening (field) has been scanned.

h. Identify each structure for appearance and size.

i. Appearance and size: Any continuous grouping of particles in which an asbestos fiber within aspect ratio greater than or equal to 5:1 and a length greater than or equal to 0.5 μm is detected shall be recorded on the count sheet. These will be designated asbestos structures and will be classified as fibers, bundles, clusters, or matrices. Record as individual fibers any contiguous grouping having 0, 1, or 2 definable intersections. Groupings having more than 2 intersections are to be described as cluster or matrix. See the following Figure 5:

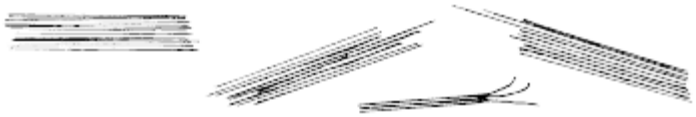
FIGURE 5--COUNTING GUIDELINES USED IN DETERMINING ASBESTOS STRUCTURES

Count as 1 fiber; 1 structure; no intersections.

Count as 2 fibers if space between fibers is greater than width of 1 fiber diameter or number of intersections is equal to or less than 1.

Count as 3 structures if space between fibers is greater than width of 1 fiber diameter or if the number of intersections is equal to or less than 2.

Count bundles as 1 structure; 3 or more parallel fibrils less than 1 fiber diameter separation.



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Count clusters as 1 structure; fibers having greater than or equal to 3 intersections.

Count matrix as 1 structure.

DO NOT COUNT AS STRUCTURES:

Fiber protrusion <5:1 Aspect Ratio

No fiber protusion

Fiber protrusion <0.5 micrometer

<0.5 micrometer in length
<5:1 Aspect Ratio

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An intersection is a non-parallel touching or crossing of fibers, with the projection having an aspect ratio of 5:1 or greater. Combinations such as a matrix and cluster, matrix and bundle, or bundle and cluster are categorized by the dominant fiber quality -- cluster, bundle, and matrix, respectively. Separate categories will be maintained for fibers less than 5 µm and for fibers greater than or equal to 5 µm in length. Not required, but useful, may be to record the fiber length in 1 µm intervals. (Identify each structure morphologically and analyze it as it enters the "window".)

(1) *Fiber.* A structure having a minimum length greater than 0.5 µm and an aspect ratio (length to width) of 5:1 or greater and substantially parallel sides. Note the appearance of the end of the fiber, i.e., whether it is flat, rounded or dovetailed, no intersections.

(2) *Bundle.* A structure composed of 3 or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

(3) *Cluster.* A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group; groupings must have more than 2 intersections.

(4) *Matrix.* Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

(5) *NSD.* Record NSD when no structures are detected in the field.

(6) *Intersection.* Non-parallel touching or crossing of fibers, with the projection having an aspect ratio 5:1 or greater.

ii. Structure Measurement.

(1) Recognize the structure that is to be sized.

(2) Memorize its location in the "window" relative to the sides, inscribed square and to other particulates in the field so this exact location can be found again when scanning is resumed.

(3) Measure the structure using the scale on the screen.

(4) Record the length category and structure type classification on the count sheet after the field number and fiber number.

(5) Return the fiber to its original location in the window and scan the rest of the field for other fibers; if the direction of travel is not remembered, return to the right side of the field and begin the traverse again.

i. Visual identification of Electron Diffraction (ED) patterns is required for each asbestos structure counted which would cause the analysis to exceed the 70 s/mm ^{2} concentration. (Generally this means the first four fibers identified as asbestos must exhibit an identifiable diffraction pattern for chrysotile or amphibole.)

i. Center the structure, focus, and obtain an ED pattern. (See Microscope Instruction Manual for more detailed instructions.)

ii. From a visual examination of the ED pattern, obtained with a short camera length, classify the observed structure as belonging to one of the following classifications: chrysotile, amphibole, or nonasbestos.

(1) Chrysotile: The chrysotile asbestos pattern has characteristic streaks on the layer lines other than the central line and some streaking also on the central line. There will be spots of

normal sharpness on the central layer line and on alternate lines (2nd, 4th, etc.). The repeat distance between layer lines is 0.53 nm and the center doublet is at 0.73 nm. The pattern should display (002), (110), (130) diffraction maxima; distances and geometry should match a chrysotile pattern and be measured semiquantitatively.

(2) Amphibole Group [includes grunerite (amosite), crocidolite, anthophyllite, tremolite, and actinolite]: Amphibole asbestos fiber patterns show layer lines formed by very closely spaced dots, and the repeat distance between layer lines is also about 0.53 nm. Streaking in layer lines is occasionally present due to crystal structure defects.

(3) Nonasbestos: Incomplete or unobtainable ED patterns, a nonasbestos EDXA, or a nonasbestos morphology.

iii. The micrograph number of the recorded diffraction patterns must be reported to the client and maintained in the laboratory's quality assurance records. The records must also demonstrate that the identification of the pattern has been verified by a qualified individual and that the operator who made the identification is maintaining at least an 80 percent correct visual identification based on his measured patterns. In the event that examination of the pattern by the qualified individual indicates that the pattern had been misidentified visually, the client shall be contacted. If the pattern is a suspected chrysotile, take a photograph of the diffraction pattern at 0 degrees tilt. If the structure is suspected to be amphibole, the sample may have to be tilted to obtain a simple geometric array of spots.

j. Energy Dispersive X-Ray Analysis (EDXA).

i. Required of all amphiboles which would cause the analysis results to exceed the 70 s/mm ^{2} concentration. (Generally speaking, the first 4 amphiboles would require EDXA.)

ii. Can be used alone to confirm chrysotile after the 70 s/mm ^{2} concentration has been exceeded.

iii. Can be used alone to confirm all nonasbestos.

iv. Compare spectrum profiles with profiles obtained from asbestos standards. The closest match identifies and categorizes the structure.

v. If the EDXA is used for confirmation, record the properly labeled spectrum on a computer disk, or if a hard copy, file with analysis data.

vi. If the number of fibers in the nonasbestos class would cause the analysis to exceed the 70 s/mm ^{2} concentration, their identities must be confirmed by EDXA or measurement of a zone axis diffraction pattern to establish that the particles are nonasbestos.

k. Stopping Rules.

i. If more than 50 asbestiform structures are counted in a particular grid opening, the analysis may be terminated.

ii. After having counted 50 asbestiform structures in a minimum of 4 grid openings, the analysis may be terminated. The grid opening in which the 50th fiber was counted must be completed.

iii. For blank samples, the analysis is always continued until 10 grid openings have been analyzed.

iv. In all other samples the analysis shall be continued until an analytical sensitivity of 0.005 s/cm ^{3} is reached.

l. Recording Rules. The count sheet should contain the following information:

i. Field (grid opening): List field number.

ii. Record "NSD" if no structures are detected.

iii. Structure information.

(1) If fibers, bundles, clusters, and/or matrices are found, list them in consecutive numerical order, starting over with each field.

(2) Length. Record length category of asbestos fibers examined. Indicate if less than 5 µm or greater than or equal to 5 µm.

(3) Structure Type. Positive identification of asbestos fibers is required by the method. At least one diffraction pattern of each fiber type from every five samples must be recorded and compared with a standard diffraction pattern. For each asbestos fiber reported, both a morphological descriptor and an identification descriptor shall be specified on the count sheet.

(4) Fibers classified as chrysotile must be identified by diffraction and/or X-ray analysis and recorded on the count sheet. X-ray analysis alone can be used as sole identification only after 70s/mm ^{2} have been exceeded for a particular sample.

(5) Fibers classified as amphiboles must be identified by X-ray analysis and electron diffraction and recorded on the count sheet. (X-ray analysis alone can be used as sole identification only after 70s/mm ^{2} have been exceeded for a particular sample.)

(6) If a diffraction pattern was recorded on film, the micrograph number must be indicated on the count sheet.

(7) If an electron diffraction was attempted and an appropriate spectra is not observed, N should be recorded on the count sheet.

(8) If an X-ray analysis is attempted but not observed, N should be recorded on the count sheet.

(9) If an X-ray analysis spectrum is stored, the file and disk number must be recorded on the count sheet.

m. Classification Rules.

i. *Fiber.* A structure having a minimum length greater than or equal to 0.5 µm and an aspect ratio (length to width) of 5:1 or greater and substantially parallel sides. Note the appearance of the end of the fiber, i.e., whether it is flat, rounded or dovetailed.

ii. *Bundle.* A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter.

iii. *Cluster.* A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections.

iv. *Matrix.* Fiber or fibers with one end free and the other end embedded in or hidden by a particulate. The exposed fiber must meet the fiber definition.

v. *NSD.* Record NSD when no structures are detected in the field.

n. After all necessary analyses of a particle structure have been completed, return the goniometer stage to 0 degrees, and return the structure to its original location by recall of the original location.

o. Continue scanning until all the structures are identified, classified and sized in the field.

p. Select additional fields (grid openings) at low magnification; scan at a chosen magnification (15,000 to 20,000X screen magnification); and analyze until the stopping rule becomes applicable.

q. Carefully record all data as they are being collected, and check for accuracy.

r. After finishing with a grid, remove it from the microscope, and replace it in the appropriate grid hold. Sample grids must be stored for a minimum of 1 year from the date of the analysis; the sample cassette must be retained for a minimum of 30 days by the laboratory or returned at the client's request.

H. Sample Analytical Sequence

1. Carry out visual inspection of work site prior to air monitoring.

2. Collect a minimum of five air samples inside the work site and five samples outside the work site. The indoor and outdoor samples shall be taken during the same time period.

3. Analyze the abatement area samples according to this protocol. The analysis must meet the 0.005 s/cm ^{3} analytical sensitivity.

4. Remaining steps in the analytical sequence are contained in Unit IV. of this Appendix.

I. Reporting

The following information must be reported to the client. See the following Table II:

TABLE II--EXAMPLE LABORATORY LETTERHEAD

Laboratory I.D.	Client I.D.	FILTER MEDIA DATA				Analyzed Area, mm^2	Sample Volume, cc
		Type	Diameter, mm	Effective Area,mm^2	Pore Size, µm		

INDIVIDUAL ANALYTICAL RESULTS

Laboratory I.D.	Client I.D.	# Asbestos Structures	Analytical Sensitivity, s/cc	CONCENTRATION	
				Structures/mm^2	Structures/cc

The analysis was carried out to the approved TEM method. This laboratory is in compliance with the quality specified by the method.

Authorized Signature

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1. Concentration in structures per square millimeter and structures per cubic centimeter.

2. Analytical sensitivity used for the analysis.

3. Number of asbestos structures.

4. Area analyzed.

5. Volume of air samples (which was initially provided by client).

6. Average grid size opening.

7. Number of grids analyzed.

8. Copy of the count sheet must be included with the report.

9. Signature of laboratory official to indicate that the laboratory met specifications of the AHERA method.

10. Report form must contain official laboratory identification (e.g., letterhead).

11. Type of asbestos.

J. Calibration Methodology

Note: Appropriate implementation of the method requires a person knowledgeable in electron diffraction and mineral identification by ED and EDXA. Those inexperienced laboratories wishing to develop capabilities may acquire necessary knowledge through analysis of appropriate standards and by following detailed methods as described in References 8 and 10 of Unit III.L.

1. *Equipment Calibration.* In this method, calibration is required for the air-sampling equipment and the transmission electron microscope (TEM).

a. *TEM Magnification.* The magnification at the fluorescent screen of the TEM must be calibrated at the grid opening magnification (if used) and also at the magnification used for fiber counting. This is performed with a cross grating replica. A logbook must be maintained, and the dates of calibration depend on the past history of the particular microscope; no frequency is specified. After any maintenance of the microscope that involved adjustment of the power supplied to the lenses or the high-voltage system or the mechanical disassembly of the electron optical column apart from filament exchange, the magnification must be recalibrated. Before the TEM calibration is performed, the analyst must ensure that the cross grating replica is placed at the same distance from the objective lens as the specimens are. For instruments that incorporate an eucentric tilting specimen stage, all speciments and the cross grating replica must be placed at the eucentric position.

b. Determination of the TEM magnification on the fluorescent screen.

i. Define a field of view on the fluorescent screen either by markings or physical boundaries. The field of view must be measurable or previously inscribed with a scale or concentric circles (all scales should be metric).

ii. Insert a diffraction grating replica (for example a grating containing 2,160 lines/mm) into the specimen holder and place into the microscope. Orient the replica so that the grating lines fall perpendicular to the scale on the TEM fluorescent screen. Ensure that the goniometer stage tilt is 0 degrees.

iii. Adjust microscope magnification to 10,000X or 20,000X. Measure the distance (mm) between two widely separated lines on the grating replica. Note the number of spaces between the lines. Take care to measure between the same relative positions on the lines (e.g., between left edges of lines).

Note: The more spaces included in the measurement, the more accurate the final calculation. On most microscopes, however, the magnification is substantially constant only within the central 8-10 cm diameter region of the fluorescent screen.

iv. Calculate the true magnification (M) on the fluorescent screen:

M=XG/Y

where:

X=total distance (mm) between the designated grating lines;

G=calibration constant of the grating replica (lines/mm):

Y=number of grating replica spaces counted along X.

c. Calibration of the EDXA System. Initially, the EDXA system must be calibrated by using two reference elements to calibrate the energy scale of the instrument. When this has been completed in accordance with the manufacturer's instructions, calibration in terms of the different types of asbestos can proceed. The EDXA detectors vary in both solid angle of detection and in window thickness. Therefore, at a particular accelerating voltage in use on the TEM, the count rate obtained from specific dimensions of fiber will vary both in absolute X-ray count rate and in the relative X-ray peak heights for different elements. Only a few minerals are relevant for asbestos abatement work, and in this procedure the calibration is specified in terms of a "fingerprint" technique. The EDXA spectra must be recorded from individual fibers of the relevant minerals, and identifications are made on the basis of semiquantitative comparisons with these reference spectra.

d. Calibration of Grid Openings.

i. Measure 20 grid openings on each of 20 random 200-mesh copper grids by placing a grid on a glass slide and examining it under the PCM. Use a calibrated graticule to measure the average field diameter and use this number to calculate the field area for an average grid opening. Grids are to be randomly selected from batches up to 1,000.

Note: A grid opening is considered as one field.

ii. The mean grid opening area must be measured for the type of specimen grids in use. This can be accomplished on the TEM at a properly calibrated low magnification or on an optical microscope at a magnification of approximately 400X by using an eyepiece fitted with a scale that has been calibrated against a stage micrometer. Optical microscopy utilizing manual or automated procedures may be used providing instrument calibration can be verified.

e. Determination of Camera Constant and ED Pattern Analysis.

i. The camera length of the TEM in ED operating mode must be calibrated before ED patterns on unknown samples are observed. This can be achieved by using a carbon-coated grid on which a thin film of gold has been sputtered or evaporated. A thin film of gold is evaporated on the specimen TEM grid to obtain zone-axis ED patterns superimposed with a ring pattern from the polycrystalline gold film.

ii. In practice, it is desirable to optimize the thickness of the gold film so that only one or two

sharp rings are obtained on the superimposed ED pattern. Thicker gold film would normally give multiple gold rings, but it will tend to mask weaker diffraction spots from the unknown fibrous particulates. Since the unknown d-spacings of most interest in asbestos analysis are those which lie closest to the transmitted beam, multiple gold rings are unnecessary on zone-axis ED patterns. An average camera constant using multiple gold rings can be determined. The camera constant is one-half the diameter, D, of the rings times the interplanar spacing, d, of the ring being measured.

K. Quality Control/Quality Assurance Procedures (Data Quality Indicators)

Monitoring the environment for airborne asbestos requires the use of sensitive sampling and analysis procedures. Because the test is sensitive, it may be influenced by a variety of factors. These include the supplies used in the sampling operation, the performance of the sampling, the preparation of the grid from the filter and the actual examination of this grid in the microscope. Each of these unit operations must produce a product of defined quality if the analytical result is to be a reliable and meaningful test result. Accordingly, a series of control checks and reference standards is performed along with the sample analysis as indicators that the materials used are adequate and the operations are within acceptable limits. In this way, the quality of the data is defined and the results are of known value. These checks and tests also provide timely and specific warning of any problems which might develop within the sampling and analysis operations. A description of these quality control/quality assurance procedures is summarized in the following Table III:

TABLE III--SUMMARY OF LABORATORY DATA QUALITY OBJECTIVES

Unit Operation	QC Check	Frequency	Conformance Expectation
Sample receiving	Review of receiving report	Each sample	95% complete
Sample custody	Review of chain-of-custody record	Each sample	95% complete
Sample preparation	Supplies and reagents	On receipt	Meet specs. or reject
	Grid opening size	20 openings/20 grids/lot of 1000 or 1 opening/sample	100%
	Special clean area monitoring	After cleaning or service	Meet specs or reclean
	Laboratory blank	1 per prep series or 10%	Meet specs. or reanalyze series
	Plasma etch blank	1 per 20 samples	75%
	Multiple preps (3 per sample)	Each sample	One with cover of 15 complete grid sqs.
Sample analysis	System check	Each day	Each day
	Alignment check	Each day	Each day
	Magnification calibration with low and high standards	Each month or after service	95%
	ED calibration by gold standard	Weekly	95%
	EDS calibration by copper line	Daily	95%
Performance check	Laboratory blank (measure of cleanliness)	Prep 1 per series or 10% read 1 per 25 samples	Meet specs or reanalyze series
	Replicate counting (measure of precision)	1 per 100 samples	1.5 x Poisson Std. Dev.
	Duplicate analysis (measure of reproducibility)	1 per 100 samples	2 x Poisson Std. Dev.
	Known samples of typical materials (working standards)	Training and for comparison with unknowns	100%
	Analysis of NBS SRM 1876 and/or RM 8410 (measure of accuracy and comparability)	1 per analyst per year	1.5 x Poisson Std. Dev.
	Data entry review (data validation and measure of completeness)	Each sample	95%
	Record and verify ID electron diffraction pattern of structure	1 per 5 samples	80% accuracy
Calculations and data reduction	Hand calculation of automated data reduction procedure or independent recalculation of hand-calculated data	1 per 100 samples	85%

1. When the samples arrive at the laboratory, check the samples and documentation for completeness and requirements before initiating the analysis.

2. Check all laboratory reagents and supplies for acceptable asbestos background levels.

3. Conduct all sample preparation in a clean room environment monitored by laboratory blanks and special testing after cleaning or servicing the room.

4. Prepare multiple grids of each sample.

5. Provide laboratory blanks with each sample batch. Maintain a cumulative average of these results. If this average is greater than 53 f/mm ^{2} per 10 200-mesh grid openings, check the

system for possible sources of contamination.

6. Check for recovery of asbestos from cellulose ester filters submitted to plasma asher.

7. Check for asbestos carryover in the plasma asher by including a blank alongside the positive control sample.

8. Perform a systems check on the transmission electron microscope daily.

9. Make periodic performance checks of magnification, electron diffraction and energy dispersive X-ray systems as set forth in Table III of Unit III.K.

10. Ensure qualified operator performance by evaluation of replicate counting, duplicate analysis, and standard sample comparisons as set forth in Table III of Unit III.K.

11. Validate all data entries.

12. Recalculate a percentage of all computations and automatic data reduction steps as specified in Table III.

13. Record an electron diffraction pattern of one asbestos structure from every five samples that contain asbestos. Verify the identification of the pattern by measurement or comparison of the pattern with patterns collected from standards under the same conditions.

The outline of quality control procedures presented above is viewed as the minimum required to assure that quality data is produced for clearance testing of an asbestos abated area. Additional information may be gained by other control tests. Specifics on those control procedures and options available for environmental testing can be obtained by consulting References 6, 7, and 11 of Unit III.L.

L. References

For additional background information on this method the following references should be consulted.

1. "Guidelines for Controlling Asbestos-Containing Materials in Buildings," EPA 560/5-85-024, June 1985.

2. "Measuring Airborne Asbestos Following an Abatement Action," USEP/Office of Pollution Prevention and Toxics, EPA 600/4-85-049, 1985.

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5. Quality Assurance Handbook for Air Pollution Measurement System. Ambient Air Methods, EPA 600/4-77-027a, USEPA, Office of Research and Development, 1977.

6. Method 2A: Direct Measurement of Gas Volume Through Pipes and Small Ducts. 40 CFR Part 60 Appendix A.

7. Burdette, G.J. Health & Safety Exec., Research & Lab. Services Div., London, "Proposed Analytical Method for Determination of Asbestos in Air."

8. Chatfield, E.J., Chatfield Tech. Cons., Ltd., Clark, T., PEI Assoc. "Standard Operating Procedure for Determination of Airborne Asbestos Fibers by Transmission Electron Microscopy

Using Polycarbonate Membrane Filters." WERL SOP 87-1, March 5, 1987.

9. NIOSH. Method 7402 for Asbestos Fibers, December 11, 1986 Draft.

10. Yamate, G., S.C. Agarwall, R.D. Gibbons, IIT Research Institute, "Methodology for the Measurement of Airborne Asbestos by Electron Microscopy." Draft report, USEPA Contract 68-02-3266, July 1984.

11. Guidance to the Preparation of Quality Assurance Project Plans. USEPA, Office of Pollution Prevention and Toxics, 1984.

IV. Mandatory Interpretation of Transmission Electron Microscopy Results to Determine Completion of Response Actions

A. Introduction

A response action is determined to be completed by TEM when the abatement area has been cleaned and the airborne asbestos concentration inside the abatement area is no higher than concentrations at locations outside the abatement area. "Outside" means outside the abatement area, but not necessarily outside the building. EPA reasons that an asbestos removal contractor cannot be expected to clean an abatement area to an airborne asbestos concentration that is lower than the concentration of air entering the abatement area from outdoors or from other parts of the building. After the abatement area has passed a thorough visual inspection, and before the outer containment barrier is removed, a minimum of five air samples inside the abatement area and a minimum of five air samples outside the abatement area must be collected. Hence, the response action is determined to be completed when the average airborne asbestos concentration measured inside the abatement area is not statistically different from the average airborne asbestos concentration measured outside the abatement area.

The inside and outside concentrations are compared by the Z-test, a statistical test that takes into account the variability in the measurement process. A minimum of five samples inside the abatement area and five samples outside the abatement area are required to control the false negative error rate, i.e., the probability of declaring the removal complete when, in fact, the air concentration inside the abatement area is significantly higher than outside the abatement area. Additional quality control is provided by requiring three blanks (filters through which no air has been drawn) to be analyzed to check for unusually high filter contamination that would distort the test results.

When volumes greater than or equal to 1,199 L for a 25 mm filter and 2,799 L for a 37 mm filter have been collected and the average number of asbestos structures on samples inside the abatementareaisnogreater than 70 s/mm ^{2} of filter, the response action may be considered complete without comparing the inside samples to the outside samples. EPA is permitting this initial screening test to save analysis costs in situations where the airborne asbestos concentration is sufficiently low so that it cannot be distinguished from the filter contamination/background level (fibers deposited on the filter that are unrelated to the air being sampled). The screening test cannot be used when volumes of less than 1,199 L for 25 mm filter or 2,799 L for a 37 mm filter are collected because the ability to distinguish levels significantly different from filter background is reduced at low volumes.

The initial screening test is expressed in structures per square millimeter of filter because filter background levels come from sources other than the air being sampled and cannot be meaningfully expressed as a concentration per cubic centimeter of air. The value of 70 s/mm ^{2} is based on the experience of the panel of microscopists who consider one structure in 10 grid openings (each grid opening with an area of 0.0057 mm ^{2}) to be comparable with contamination/background levels of blank filters. The decision is based, in part, on Poisson statistics which indicate that four structures must be counted on a filter before the fiber count is statistically distinguishable from the count for one structure. As more information on the performance of the method is collected, this criterion may be modified. Since different

combinations of the number and size of grid openings are permitted under the TEM protocol, the criterion is expressed in structures per square millimeter of filter to be consistent across all combinations. Four structures per 10 grid openings corresponds to approximately 70 s/mm ^{2}.

B. Sample Collection and Analysis

1. A minimum of 13 samples is required: five samples collected inside the abatement area, five samples collected outside the abatement area, two field blanks, and one sealed blank.

2. Sampling and TEM analysis must be done according to either the mandatory or nonmandatory protocols in Appendix A. At least 0.057 mm ^{2} of filter must be examined on blank filters.

C. Interpretation of Results

1. The response action shall be considered complete if either:

a. Each sample collected inside the abatement area consists of at least 1,199 L of air for a 25 mm filter, or 2,799 L of air for a 37 mm filter, and the arithmetic mean of their asbestos structure concentrations per square millimeter of filter is less than or equal to 70 s/mm ^{2}; or

b. The three blank samples have an arithmetic mean of the asbestos structure concentration on the blank filtersthatislessthanor equal to 70 s/mm ^{2} and the average airborne asbestos concentration measured inside the abatement area is not statistically higher than the average airborne asbestos concentration measured outside the abatement area as determined by the Z-test. The Z-test is carried out by calculating

$$Z = \frac{\bar{Y}_I - \bar{Y}_O}{0.8(1/n_I + 1/n_O)^{1/2}}$$

where YI is the average of the natural logarithms of the inside samples and YO is the average of the natural logarithms of the outside samples, nI is the number of inside samples and nO is the number of outside samples. The response action is considered complete if Z is less than or equal to 1.65.

Note: When no fibers are counted, the calculated detection limit for that analysis is inserted for the concentration.

2. If the abatement site does not satisfy either (1) or (2) of this Section C, the site must be recleaned and a new set of samples collected.

D. Sequence for Analyzing Samples

It is possible to determine completion of the response action without analyzing all samples. Also, at any point in the process, a decision may be made to terminate the analysis of existing samples, reclean the abatement site, and collect a new set of samples. The following sequence is outlined to minimize the number of analyses needed to reach a decision.

1. Analyze the inside samples.

2. If at least 1,199 L of air for a 25 mm filter or 2,799 L of air for a 37 mm filter is collected for each inside sample and the arithmetic mean concentration of structures per square millimeter of filter is less than or equal to 70 s/mm ^{2}, the response action is complete and no further analysis is needed.

3. If less than 1,199 L of air for a 25 mm filter or 2,799 L of air for a 37 mm filter is collected for any of the inside samples, or the arithmetic mean concentration of structures per square millimeteroffilterisgreaterthan 70 s/mm ^{2}, analyze the three blanks.

4. If the arithmetic mean concentration of structures per square millimeter on the blank filters is greater than 70 s/mm ^{2}, terminate the analysis, identify and correct the source of blank contamination, and collect a new set of samples.

5. If the arithmetic mean concentration of structures per square millimeter on the blank filters is less than or equal to 70 s/mm ^{2}, analyze the outside samples and perform the Z-test.

6. If the Z-statistic is less than or equal to 1.65, the response action is complete. If the Z-statistic is greater than 1.65, reclean the abatement site and collect a new set of samples.

[52 FR 41857, Oct. 30, 1987]

Appendix B to Subpart E of Part 763 [Reserved]

Regulations (Standards - 29 CFR)

Sampling and Analysis - Non-mandatory - 1926.1101 App B

Regulations (Standards - 29 CFR) - Table of Contents

- **Part Number:** 1926
- **Part Title:** Safety and Health Regulations for Construction
- **Subpart:** Z
- **Subpart Title:** Toxic and Hazardous Substances
- **Standard Number:** 1926.1101 App B
- **Title:** Sampling and Analysis - Non-mandatory

Matrix

Matrix:
 OSHA Permissible Exposure Limits:
   Time Weighted Average..... 0.1 fiber/cc
   Excursion Level (30 minutes)..... 1.0 fiber/cc
Collection Procedure:
A known volume of air is drawn through a 25-mm diameter cassette containing a mixed-cellulose ester filter. The cassette must be equipped with an electrically conductive 50-mm extension cowl. The sampling time and rate are chosen to give a fiber density of between 100 to 1,300 fibers/mm2 on the filter.

Recommended Sampling Rate..... 0.5 to 5.0 liters/minute (L/min)
Recommended Air Volumes:
 Minimum..... 25 L
 Maximum..... 2,400 L

Analytical Procedure:

A portion of the sample filter is cleared and prepared for asbestos fiber counting by Phase Contrast Microscopy (PCM) at 400X.

Commercial manufacturers and products mentioned in this method are for descriptive use only and do not constitute endorsements by USDOL-OSHA. Similar products from other sources can be substituted.

1. Introduction

This method describes the collection of airborne asbestos fibers using calibrated sampling pumps with mixed-

cellulose ester (MCE) filters and analysis by phase contrast microscopy (PCM). Some terms used are unique to this method and are defined below: Asbestos: A term for naturally occurring fibrous minerals. Asbestos includes chrysotile, crocidolite, amosite (cummingtonite-grunerite asbestos), tremolite asbestos, actinolite asbestos, anthophyllite asbestos, and any of these minerals that have been chemically treated and/or altered. The precise chemical formulation of each species will vary with the location from which it was mined. Nominal compositions are listed:

```
Chrysotile.............  Mg(3)Si(2)O(5)(OH)(4)
Crocidolite............  Na(2)Fe(3)(2)+Fe(2)(3)+Si(8)O(22)(OH)(2)
Amosite................  (Mg,Fe)(7)Si(8)O(22)(OH)(2)
Tremolite-actinolite...  Ca(2)(Mg,Fe)(5)Si(8)O(22)(OH)(2)
Anthophyllite..........  (Mg,Fe)(7)Si(8)O(22)(OH)(2)
```

Asbestos Fiber: A fiber of asbestos which meets the criteria specified below for a fiber.

Aspect Ratio: The ratio of the length of a fiber to it's diameter (e.g. 3:1, 5:1 aspect ratios).

Cleavage Fragments: Mineral particles formed by comminution of minerals, especially those characterized by parallel sides and a moderate aspect ratio (usually less than 20:1).

Detection Limit: The number of fibers necessary to be 95% certain that the result is greater than zero.

Differential Counting: The term applied to the practice of excluding certain kinds of fibers from the fiber count because they do not appear to be asbestos.

Fiber: A particle that is 5 um or longer, with a length-to-width ratio of 3 to 1 or longer.

Field: The area within the graticule circle that is superimposed on the microscope image.

Set: The samples which are taken, submitted to the laboratory, analyzed, and for which, interim or final result reports are generated.

Tremolite, Anthophyllite, and Actinolite: The non-asbestos form of these minerals which meet the definition of a fiber. It includes any of these minerals that have been chemically treated and/or altered.

Walton-Beckett Graticule: An eyepiece graticule specifically designed for asbestos fiber counting. It consists of a circle with a projected diameter of 100 plus or minus 2 um (area of about 0.00785 mm(2)) with a crosshair having tic-marks at 3-um intervals in one direction and 5-um in the orthogonal direction. There are marks around the periphery of the circle to demonstrate the proper sizes and shapes of fibers. This design is reproduced in Figure 1. The disk is placed in one of the microscope eyepieces so that the design is superimposed on the field of view.

1.1. History

Early surveys to determine asbestos exposures were conducted using impinger counts of total dust with the counts expressed as million particles per cubic foot. The British Asbestos Research Council recommended filter membrane counting in 1969. In July 1969, the Bureau of Occupational Safety and Health published a filter membrane method for counting asbestos fibers in the United States. This method was refined by NIOSH and published as P & CAM 239. On May 29, 1971, OSHA specified filter membrane sampling with phase contrast counting for evaluation of asbestos exposures at work sites in the United States. The use of this technique was again required by OSHA in 1986. Phase contrast microscopy has continued to be the method of choice for the measurement of occupational exposure to asbestos.

1.2. Principle

Air is drawn through a MCE filter to capture airborne asbestos fibers. A wedge shaped portion of the filter is removed, placed on a glass microscope slide and made transparent. A measured area (field) is viewed by PCM. All the fibers meeting defined criteria for asbestos are counted and considered a measure of the airborne asbestos concentration.

1.3. Advantages and Disadvantages

There are four main advantages of PCM over other methods:

(1) The technique is specific for fibers. Phase contrast is a fiber counting technique which excludes non-fibrous particles from the analysis.

(2) The technique is inexpensive and does not require specialized knowledge to carry out the analysis for total fiber counts.

(3) The analysis is quick and can be performed on-site for rapid determination of air concentrations of asbestos fibers.

(4) The technique has continuity with historical epidemiological studies so that estimates of expected disease can be inferred from long-term determinations of asbestos exposures.

The main disadvantage of PCM is that it does not positively identify asbestos fibers. Other fibers which are not asbestos may be included in the count unless differential counting is performed. This requires a great deal of experience to adequately differentiate asbestos from non-asbestos fibers. Positive identification of asbestos must be performed by polarized light or electron microscopy techniques. A further disadvantage of PCM is that the smallest visible fibers are about 0.2 um in diameter while the finest asbestos fibers may be as small as 0.02 um in diameter. For some exposures, substantially more fibers may be present than are actually counted.

1.4. Workplace Exposure

Asbestos is used by the construction industry in such products as shingles, floor tiles, asbestos cement, roofing felts, insulation and acoustical products. Non-construction uses include brakes, clutch facings, paper, paints, plastics, and fabrics. One of the most significant exposures in the workplace is the removal and encapsulation of asbestos in schools, public buildings, and homes. Many workers have the potential to be exposed to asbestos during these operations.

About 95% of the asbestos in commercial use in the United States is chrysotile. Crocidolite and amosite make up most of the remainder. Anthophyllite and tremolite or actinolite are likely to be encountered as contaminants in various industrial products.

1.5. Physical Properties

Asbestos fiber possesses a high tensile strength along its axis, is chemically inert, non-combustible, and heat resistant. It has a high electrical resistance and good sound absorbing properties. It can be weaved into cables, fabrics or other textiles, and also matted into asbestos papers, felts, or mats.

2. Range and Detection Limit

2.1. The ideal counting range on the filter is 100 to 1,300 fibers/mm(2). With a Walton-Beckett graticule this range is equivalent to 0.8 to 10 fibers/field. Using NIOSH counting statistics, a count of 0.8 fibers/field would give an approximate coefficient of variation (CV) of 0.13.

2.2. The detection limit for this method is 4.0 fibers per 100 fields or 5.5 fibers/mm(2). This was determined using an equation to estimate the maximum CV possible at a specific concentration (95% confidence) and a Lower Control Limit of zero. The CV value was then used to determine a corresponding concentration from historical CV vs fiber relationships. As an example:

```
Lower Control Limit (95% Confidence) = AC -- 1.645(CV)(AC)

Where:

AC = Estimate of the airborne fiber concentration (fibers/cc) Setting the
    Lower Control Limit = 0 and solving for CV:
0  = AC -- 1.645(CV)(AC)
CV = 0.61
```

This value was compared with CV vs. count curves. The count at which CV = 0.61 for Leidel-Busch counting statistics or for an OSHA Salt Lake Technical Center (OSHA-SLTC) CV curve (see Appendix A for further information) was 4.4 fibers or 3.9 fibers per 100 fields, respectively. Although a lower detection limit of 4 fibers per 100 fields is supported by the OSHA-SLTC data, both data sets support the 4.5 fibers per 100 fields value.

3. Method Performance -- Precision and Accuracy

Precision is dependent upon the total number of fibers counted and the uniformity of the fiber distribution on the filter. A general rule is to count at least 20 and not more than 100 fields. The count is discontinued when 100 fibers are counted, provided that 20 fields have already been counted. Counting more than 100 fibers results in only a small gain in precision. As the total count drops below 10 fibers, an accelerated loss of precision is noted.

At this time, there is no known method to determine the absolute accuracy of the asbestos analysis. Results of samples prepared through the Proficiency Analytical Testing (PAT) Program and analyzed by the OSHA-SLTC showed no significant bias when compared to PAT reference values. The PAT samples were analyzed from 1987 to 1989 (N = 36) and the concentration range was from 120 to 1,300 fibers/mm(2).

4. Interferences

Fibrous substances, if present, may interfere with asbestos analysis.

Some common fibers are:

```
Fiberglass
Anhydrite
Plant Fibers
Perlite Veins
Gypsum
Some Synthetic Fibers
Membrane Structures
Sponge Spicules
Diatoms
Microorganisms
Wollastonite
```

The use of electron microscopy or optical tests such as polarized light, and dispersion staining may be used to differentiate these materials from asbestos when necessary.

5. Sampling

5.1. Equipment

5.1.1. Sample assembly (The assembly is shown in Figure 3). Conductive filter holder consisting of a 25-mm diameter, 3-piece cassette having a 50-mm long electrically conductive extension cowl. Backup pad, 25-mm, cellulose. Membrane filter, mixed-cellulose ester (MCE), 25-mm, plain, white, 0.4 to 1.2-um pore size.

Notes:

(a) DO NOT RE-USE CASSETTES.

(b) Fully conductive cassettes are required to reduce fiber loss to the sides of the cassette due to electrostatic attraction.

(c) Purchase filters which have been selected by the manufacturer for asbestos counting or analyze representative filters for fiber background before use. Discard the filter lot if more than 4 fibers/ 100 fields are found.

(d) To decrease the possibility of contamination, the sampling system (filter-backup pad-cassette) for asbestos is usually preassembled by the manufacturer.

(e) Other cassettes, such as the Bell-mouth, may be used within the limits of their validation.

5.1.2. Gel bands for sealing cassettes.

5.1.3. Sampling pump.

Each pump must be a battery operated, self-contained unit small enough to be placed on the monitored employee and not interfere with the work being performed. The pump must be capable of sampling at the collection rate for the required sampling time.

5.1.4. Flexible tubing, 6-mm bore.

5.1.5. Pump calibration.

Stopwatch and bubble tube/burette or electronic meter.

5.2. Sampling Procedure

5.2.1. Seal the point where the base and cowl of each cassette meet with a gel band or tape.

5.2.2. Charge the pumps completely before beginning.

5.2.3. Connect each pump to a calibration cassette with an appropriate length of 6-mm bore plastic tubing. Do not use luer connectors -- the type of cassette specified above has built-in adapters.

5.2.4. Select an appropriate flow rate for the situation being monitored. The sampling flow rate must be between 0.5 and 5.0 L/min for personal sampling and is commonly set between 1 and 2 L/min. Always choose a flow rate that will not produce overloaded filters.

5.2.5. Calibrate each sampling pump before and after sampling with a calibration cassette in-line (Note: This calibration cassette should be from the same lot of cassettes used for sampling). Use a primary standard (e.g.

bubble burette) to calibrate each pump. If possible, calibrate at the sampling site.

Note: If sampling site calibration is not possible, environmental influences may affect the flow rate. The extent is dependent on the type of pump used. Consult with the pump manufacturer to determine dependence on environmental influences. If the pump is affected by temperature and pressure changes, correct the flow rate using the formula shown in the section "Sampling Pump Flow Rate Corrections" at the end of this appendix.

5.2.6. Connect each pump to the base of each sampling cassette with flexible tubing. Remove the end cap of each cassette and take each air sample open face. Assure that each sample cassette is held open side down in the employee's breathing zone during sampling. The distance from the nose/mouth of the employee to the cassette should be about 10 cm. Secure the cassette on the collar or lapel of the employee using spring clips or other similar devices.

5.2.7. A suggested minimum air volume when sampling to determine TWA compliance is 25 L. For Excursion Limit (30 min sampling time) evaluations, a minimum air volume of 48 L is recommended.

5.2.8. The most significant problem when sampling for asbestos is overloading the filter with non-asbestos dust. Suggested maximum air sample volumes for specific environments are:

Environment	Air Vol. (L)
Asbestos removal operations (visible dust).....	100.
Asbestos removal operations (little dust).....	240.
Office environments.....	400 to 2,400.

CAUTION: Do not overload the filter with dust. High levels of non-fibrous dust particles may obscure fibers on the filter and lower the count or make counting impossible. If more than about 25 to 30% of the field area is obscured with dust, the result may be biased low. Smaller air volumes may be necessary when there is excessive non-asbestos dust in the air.

While sampling, observe the filter with a small flashlight. If there is a visible layer of dust on the filter, stop sampling, remove and seal the cassette, and replace with a new sampling assembly. The total dust loading should not exceed 1 mg.

5.2.9. Blank samples are used to determine if any contamination has occurred during sample handling. Prepare two blanks for the first 1 to 20 samples. For sets containing greater than 20 samples, prepare blanks as 10% of the samples. Handle blank samples in the same manner as air samples with one exception: Do not draw any air through the blank samples. Open the blank cassette in the place where the sample cassettes are mounted on the employee. Hold it open for about 30 seconds. Close and seal the cassette appropriately. Store blanks for shipment with the sample cassettes.

5.2.10. Immediately after sampling, close and seal each cassette with the base and plastic plugs. Do not touch or puncture the filter membrane as this will invalidate the analysis.

5.2.11. Attach and secure a sample seal around each sample cassette in such a way as to assure that the end cap and base plugs cannot be removed without destroying the seal. Tape the ends of the seal together since the seal is not long enough to be wrapped end-to-end. Also wrap tape around the cassette at each joint to keep the seal secure.

5.3. Sample Shipment

5.3.1. Send the samples to the laboratory with paperwork requesting asbestos analysis. List any known fibrous interferences present during sampling on the paperwork. Also, note the workplace operation(s) sampled.

5.3.2. Secure and handle the samples in such that they will not rattle during shipment nor be exposed to static electricity. Do not ship samples in expanded polystyrene peanuts, vermiculite, paper shreds, or excelsior. Tape sample cassettes to sheet bubbles and place in a container that will cushion the samples in such a manner that they will not rattle.

5.3.3. To avoid the possibility of sample contamination, always ship bulk samples in separate mailing containers.

6. Analysis

6.1. Safety Precautions

6.1.1. Acetone is extremely flammable and precautions must be taken not to ignite it. Avoid using large containers or quantities of acetone. Transfer the solvent in a ventilated laboratory hood. Do not use acetone near any open flame. For generation of acetone vapor, use a spark free heat source.

6.1.2. Any asbestos spills should be cleaned up immediately to prevent dispersal of fibers. Prudence should be exercised to avoid contamination of laboratory facilities or exposure of personnel to asbestos. Asbestos spills should be cleaned up with wet methods and/ or a High Efficiency Particulate-Air (HEPA) filtered vacuum.

CAUTION: Do not use a vacuum without a HEPA filter -- It will disperse fine asbestos fibers in the air.

6.2. Equipment

6.2.1. Phase contrast microscope with binocular or trinocular head.

6.2.2. Widefield or Huygenian 10X eyepieces (NOTE: The eyepiece containing the graticule must be a focusing eyepiece. Use a 40X phase objective with a numerical aperture of 0.65 to 0.75).

6.2.3. Kohler illumination (if possible) with green or blue filter.

6.2.4. Walton-Beckett Graticule, type G-22 with 100 plus or minus 2 um projected diameter.

6.2.5. Mechanical stage. A rotating mechanical stage is convenient for use with polarized light.

6.2.6. Phase telescope.

6.2.7. Stage micrometer with 0.01-mm subdivisions.

6.2.8. Phase-shift test slide, mark II (Available from PTR optics Ltd., and also McCrone).

6.2.9. Precleaned glass slides, 25 mm X 75 mm. One end can be frosted for convenience in writing sample numbers, etc., or paste-on labels can be used.

6.2.10. Cover glass #1 1/2.

6.2.11. Scalpel (#10, curved blade).

6.2.12. Fine tipped forceps.

6.2.13. Aluminum block for clearing filter (see Appendix D and Figure 4).

6.2.14. Automatic adjustable pipette, 100- to 500-uL.

6.2.15. Micropipette, 5 uL.

6.3. Reagents

6.3.1. Acetone (HPLC grade).

6.3.2. Triacetin (glycerol triacetate).

6.3.3. Lacquer or nail polish.

6.4. Standard Preparation

A way to prepare standard asbestos samples of known concentration has not been developed. It is possible to prepare replicate samples of nearly equal concentration. This has been performed through the PAT program. These asbestos samples are distributed by the AIHA to participating laboratories.

Since only about one-fourth of a 25-mm sample membrane is required for an asbestos count, any PAT sample can serve as a "standard" for replicate counting.

6.5. Sample Mounting

Note: See Safety Precautions in Section 6.1. before proceeding. The objective is to produce samples with a smooth (non-grainy) background in a medium with a refractive index of approximately 1.46. The technique below collapses the filter for easier focusing and produces permanent mounts which are useful for quality control and interlaboratory comparison.

An aluminum block or similar device is required for sample preparation.

6.5.1. Heat the aluminum block to about 70 deg.C. The hot block should not be used on any surface that can be damaged by either the heat or from exposure to acetone.

6.5.2. Ensure that the glass slides and cover glasses are free of dust and fibers.

6.5.3. Remove the top plug to prevent a vacuum when the cassette is opened. Clean the outside of the cassette if necessary. Cut the seal and/or tape on the cassette with a razor blade. Very carefully separate the base from the extension cowl, leaving the filter and backup pad in the base.

6.5.4. With a rocking motion cut a triangular wedge from the filter using the scalpel. This wedge should be one-sixth to one-fourth of the filter. Grasp the filter wedge with the forceps on the perimeter of the filter which was clamped between the cassette pieces. DO NOT TOUCH the filter with your finger. Place the filter on the glass slide sample side up. Static electricity will usually keep the filter on the slide until it is cleared.

6.5.5. Place the tip of the micropipette containing about 200 uL acetone into the aluminum block. Insert the glass slide into the receiving slot in the aluminum block. Inject the acetone into the block with slow, steady pressure on the plunger while holding the pipette firmly in place. Wait 3 to 5 seconds for the filter to clear, then remove the pipette and slide from the aluminum block.

6.5.6. Immediately (less than 30 seconds) place 2.5 to 3.5 uL of triacetin on the filter (NOTE: Waiting longer

than 30 seconds will result in increased index of refraction and decreased contrast between the fibers and the preparation. This may also lead to separation of the cover slip from the slide).

6.5.7. Lower a cover slip gently onto the filter at a slight angle to reduce the possibility of forming air bubbles. If more than 30 seconds have elapsed between acetone exposure and triacetin application, glue the edges of the cover slip to the slide with lacquer or nail polish.

6.5.8. If clearing is slow, warm the slide for 15 min on a hot plate having a surface temperature of about 50 deg.C to hasten clearing. The top of the hot block can be used if the slide is not heated too long.

6.5.9. Counting may proceed immediately after clearing and mounting are completed.

6.6. Sample Analysis

Completely align the microscope according to the manufacturer's instructions. Then, align the microscope using the following general alignment routine at the beginning of every counting session and more often if necessary.

6.6.1. Alignment

(1) Clean all optical surfaces. Even a small amount of dirt can significantly degrade the image.

(2) Rough focus the objective on a sample.

(3) Close down the field iris so that it is visible in the field of view. Focus the image of the iris with the condenser focus. Center the image of the iris in the field of view.

(4) Install the phase telescope and focus on the phase rings. Critically center the rings. Misalignment of the rings results in astigmatism which will degrade the image.

(5) Place the phase-shift test slide on the microscope stage and focus on the lines. The analyst must see line set 3 and should see at least parts of 4 and 5 but, not see line set 6 or 6. A microscope/microscopist combination which does not pass this test may not be used.

6.6.2. Counting Fibers

(1) Place the prepared sample slide on the mechanical stage of the microscope. Position the center of the wedge under the objective lens and focus upon the sample.

(2) Start counting from one end of the wedge and progress along a radial line to the other end (count in either direction from perimeter to wedge tip). Select fields randomly, without looking into the eyepieces, by slightly advancing the slide in one direction with the mechanical stage control.

(3) Continually scan over a range of focal planes (generally the upper 10 to 15 um of the filter surface) with the fine focus control during each field count. Spend at least 5 to 15 seconds per field.

(4) Most samples will contain asbestos fibers with fiber diameters less than 1 um. Look carefully for faint fiber images. The small diameter fibers will be very hard to see. However, they are an important contribution to the total count.

(5) Count only fibers equal to or longer than 5 um. Measure the length of curved fibers along the curve.

(6) Count fibers which have a length to width ratio of 3:1 or greater.

(7) Count all the fibers in at least 20 fields. Continue counting until either 100 fibers are counted or 100 fields have been viewed; whichever occurs first. Count all the fibers in the final field.

(8) Fibers lying entirely within the boundary of the Walton-Beckett graticule field shall receive a count of 1. Fibers crossing the boundary once, having one end within the circle shall receive a count of 1/2. Do not count any fiber that crosses the graticule boundary more than once. Reject and do not count any other fibers even though they may be visible outside the graticule area. If a fiber touches the circle, it is considered to cross the line.

(9) Count bundles of fibers as one fiber unless individual fibers can be clearly identified and each individual fiber is clearly not connected to another counted fiber. See Figure 1 for counting conventions.

(10) Record the number of fibers in each field in a consistent way such that filter non-uniformity can be assessed.

(11) Regularly check phase ring alignment.

(12) When an agglomerate (mass of material) covers more than 25% of the field of view, reject the field and select another. Do not include it in the number of fields counted.

(13) Perform a "blind recount" of 1 in every 10 filter wedges (slides). Re-label the slides using a person other than the original counter.

6.7. Fiber Identification

As previously mentioned in Section 1.3., PCM does not provide positive confirmation of asbestos fibers. Alternate differential counting techniques should be used if discrimination is desirable. Differential counting may include primary discrimination based on morphology, polarized light analysis of fibers, or modification of PCM data by Scanning Electron or Transmission Electron Microscopy.

A great deal of experience is required to routinely and correctly perform differential counting. It is discouraged unless it is legally necessary. Then, only if a fiber is obviously not asbestos should it be excluded from the count. Further discussion of this technique can be found in reference 8.10.

If there is a question whether a fiber is asbestos or not, follow the rule:

"WHEN IN DOUBT, COUNT."

6.8. Analytical Recommendations -- Quality Control System

6.8.1. All individuals performing asbestos analysis must have taken the NIOSH course for sampling and evaluating airborne asbestos or an equivalent course.

6.8.2. Each laboratory engaged in asbestos counting shall set up a slide trading arrangement with at least two other laboratories in order to compare performance and eliminate inbreeding of error. The slide exchange occurs at least semiannually. The round robin results shall be posted where all analysts can view individual analyst's results.

6.8.3. Each laboratory engaged in asbestos counting shall participate in the Proficiency Analytical Testing Program, the Asbestos Analyst Registry or equivalent.

6.8.4. Each analyst shall select and count prepared slides from a "slide bank". These are quality assurance counts. The slide bank shall be prepared using uniformly distributed samples taken from the workload. Fiber densities should cover the entire range routinely analyzed by the laboratory. These slides are counted blind by

all counters to establish an original standard deviation. This historical distribution is compared with the quality assurance counts. A counter must have 95% of all quality control samples counted within three standard deviations of the historical mean. This count is then integrated into a new historical mean and standard deviation for the slide.

The analyses done by the counters to establish the slide bank may be used for an interim quality control program if the data are treated in a proper statistical fashion.

7. Calculations

7.1. Calculate the estimated airborne asbestos fiber concentration on the filter sample using the following formula:

(For Equation A, Click Here)

where:

```
AC    = Airborne fiber concentration
FB    = Total number of fibers greater than 5 um counted
FL    = Total number of fields counted on the filter
BFB   = Total number of fibers greater than 5 um counted in the blank
BFL   = Total number of fields counted on the blank
ECA   = Effective collecting area of filter (385 mm(2) nominal for a
        25-mm filter.)
FR    = Pump flow rate (L/min)
MFA   = Microscope count field area (mm(2)). This is 0.00785 mm(2) for
        a Walton-Beckett Graticule.
T     = Sample collection time (min)
1,000 = Conversion of L to cc
```

Note: The collection area of a filter is seldom equal to 385 mm(2). It is appropriate for laboratories to routinely monitor the exact diameter using an inside micrometer. The collection area is calculated according to the formula:

Area = pi(d/2)(2)

7.2. Short-Cut Calculation

Since a given analyst always has the same interpupillary distance, the number of fields per filter for a particular analyst will remain constant for a given size filter. The field size for that analyst is constant (i.e. the analyst is using an assigned microscope and is not changing the reticle).

For example, if the exposed area of the filter is always 385 mm(2) and the size of the field is always 0.00785 mm(2) the number of fields per filter will always be 49,000. In addition it is necessary to convert liters of air to cc. These three constants can then be combined such that ECA/(1,000 x MFA) = 49. The previous equation simplifies to:

(For Equation B, Click Here)

7.3. Recount Calculations

As mentioned in step 13 of Section 6.6.2., a "blind recount" of 10% of the slides is performed. In all cases,

differences will be observed between the first and second counts of the same filter wedge. Most of these differences will be due to chance alone, that is, due to the random variability (precision) of the count method. Statistical recount criteria enables one to decide whether observed differences can be explained due to chance alone or are probably due to systematic differences between analysts, microscopes, or other biasing factors.

The following recount criterion is for a pair of counts that estimate AC in fibers/cc. The criterion is given at the type-I error level. That is, there is 5% maximum risk that we will reject a pair of counts for the reason that one might be biased, when the large observed difference is really due to chance.

Reject a pair of counts if:

(For Equation C, Click Here)

Where:

AC(1) = lower estimated airborne fiber concentration
AC(2) = higher estimated airborne fiber concentration
AC(avg) = average of the two concentration estimates
CV(FB) = CV for the average of the two concentration estimates

If a pair of counts are rejected by this criterion then, recount the rest of the filters in the submitted set. Apply the test and reject any other pairs failing the test. Rejection shall include a memo to the industrial hygienist stating that the sample failed a statistical test for homogeneity and the true air concentration may be significantly different than the reported value.

7.4. Reporting Results

Report results to the industrial hygienist as fibers/cc. Use two significant figures. If multiple analyses are performed on a sample, an average of the results is to be reported unless any of the results can be rejected for cause.

8. References

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8.4. NIOSH Manual of Analytical Methods, 2nd ed., Vol. 1 (DHEW/ NIOSH Pub. No. 77-157-A). National Institute for Occupational Safety and Health, Cincinnati, OH, 1977. pp. 239-1 -- 239-21.

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8.6. Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite. Final Rule, Federal Register 51:119 (20 June 1986). pp. 22612-22790.

8.7. Asbestos, Tremolite, Anthophyllite, and Actinolite, Code of Federal Regulations 1910.1001. 1988. pp. 711-752.

8.8. Criteria for a Recommended Standard -- Occupational Exposure to Asbestos (DHEW/NIOSH Pub. No. HSM 72-10267), National Institute for Occupational Safety and Health, NIOSH, Cincinnati, OH, 1972. pp. III-1 -- III-24.

8.9. Leidel, N.A., Bayer, S.G., Zumwalde, R.D., Busch, K.A., USPHS/NIOSH Membrane Filter Method for Evaluating Airborne Asbestos Fibers (DHEW/NIOSH Pub. No. 79-127). National Institute for Occupational Safety and Health, Cincinnati, OH, 1979.

8.10. Dixon, W.C., Applications of Optical Microscopy in Analysis of Asbestos and Quartz, Analytical Techniques in Occupational Health Chemistry, edited by D.D. Dollberg and A.W. Verstuyft. Wash. D.C.: American Chemical Society, (ACS Symposium Series 120) 1980. pp. 13-41.

Quality Control

The OSHA asbestos regulations require each laboratory to establish a quality control program. The following is presented as an example of how the OSHA-SLTC constructed its internal CV curve as part of meeting this requirement. Data is from 395 samples collected during OSHA compliance inspections and analyzed from October 1980 through April 1986.

Each sample was counted by 2 to 5 different counters independently of one another. The standard deviation and the CV statistic was calculated for each sample. This data was then plotted on a graph of CV vs. fibers/ mm(2). A least squares regression was performed using the following equation:

```
CV = antilog(10)[A(log(10)(x))(2)+B(log(10)(x))+C]

 where:

x = the number of fibers/mm(2)

 Application of least squares gave:

A = 0.182205
B = 0.973343
C = 0.327499

 Using these values, the equation becomes:

CV = antilog(10)[0.182205(log(10)(x))(2)-0.973343(log (10)(x))+0.327499]

Sampling Pump Flow Rate Corrections

 This correction is used if a difference greater than 5% in ambient
temperature and/or pressure is noted between calibration and sampling
sites and the pump does not compensate for the differences.

(For Equation D, Click Here)

Where:

Q(act) = actual flow rate
Q(cal) = calibrated flow rate (if a rotameter was used, the rotameter
         value)
P(cal) = uncorrected air pressure at calibration
P(act) = uncorrected air pressure at sampling site
T(act) = temperature at sampling site (K)
```

T(cal) = temperature at calibration (K)

Walton-Beckett Graticule

When ordering the Graticule for asbestos counting, specify the exact disc diameter needed to fit the ocular of the microscope and the diameter (mm) of the circular counting area. Instructions for measuring the dimensions necessary are listed:

(1) Insert any available graticule into the focusing eyepiece and focus so that the graticule lines are sharp and clear.

(2) Align the microscope.

(3) Place a stage micrometer on the microscope object stage and focus the microscope on the graduated lines.

(4) Measure the magnified grid length, PL (um), using the stage micrometer.

(5) Remove the graticule from the microscope and measure its actual grid length, AL (mm). This can be accomplished by using a mechanical stage fitted with verniers, or a jeweler's loupe with a direct reading scale.

(6) Let D = 100 um. Calculate the circle diameter, d(c)(mm), for the Walton-Beckett graticule and specify the diameter when making a purchase:

$$d(c) = \frac{AL \times D}{PL}$$

Example:

If PL = 108 um, AL = 2.93 mm and D = 100 um,

then,

$$d(c) = \frac{2.93 \times 100}{108} = 2.71\text{mm}$$

(7) Each eyepiece-objective-reticle combination on the microscope must be calibrated. Should any of the three be changed (by zoom adjustment, disassembly, replacement, etc.), the combination must be recalibrated. Calibration may change if interpupillary distance is changed.

Measure the field diameter, D (acceptable range: 100 plus or minus 2 um) with a stage micrometer upon receipt of the graticule from the manufacturer. Determine the field area (mm(2)).

Field Area = pi(D/2)(2)
If D = 100 um = 0.1 mm, then
Field Area = pi(0.1 mm/2)(2) = 0.00785 mm(2)

The Graticule is available from: Graticules Ltd., Morley Road, Tonbridge TN9 IRN, Kent, England (Telephone 011-44-732-359061). Also available from PTR Optics Ltd., 145 Newton Street, Waltham, MA 02154 [telephone (617) 891-6000] or McCrone Accessories and Components, 2506 S. Michigan Ave.,

Chicago, IL 60616 [phone (312)-842-7100]. The graticule is custom made for each microscope.

(For Figure 1 of Walton-Beckett Graticule, Click Here)

Counts for the Fibers in the Figure

Structure No.	Count	Explanation
1 to 6.....	1	Single fibers all contained within the Circle.
7.....	1/2	Fiber crosses circle once.
8.....	0	Fiber too short.
9.....	2	Two crossing fibers.
10.....	0	Fiber outside graticule.
11.....	0	Fiber crosses graticule twice.
12.....	1/2	Although split, fiber only crosses once.

[60 FR 33972, June 29, 1995]

Next Standard (1926.1101 App C)

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

Libby Asbestos Superfund Site
Standard Operating Procedure
Field Logbook Content and Control

Prepared by: _____ Date: 7/23/12
CDM Smith

Approved by: _____ Date: 7/23/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--
1	7/23/12	To maintain consistency with requirements for completing other field documentation (e.g., field sample data sheets), eliminated the requirement to strike through, initial, and date any self-adhesive labels placed in the logbook.

1.0 Objective

Logbooks are an essential tool to document field activities conducted by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for the content and control of Libby Site field logbooks. Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Ruler or similar scale – Used with a property-specific drawing or plan to measure distance and sizes of objects, buildings, and zones.

Site – All buildings (if applicable) and land within the boundaries of the EPA's designated geounits, which may represent individual properties within the Libby Site, a collection of properties, or a larger geographical area.

2.2 Discussion

Field logbooks are an accounting of observations and/or activities occurring at or associated with the Libby Site. Field logbooks are also used to duly document changes to or deviations from governing documents referencing this SOP. Information recorded in field logbooks includes date/time, site personnel, observations, calculations, weather, locations of field activities, and a description of the field activity, methods, instruments, and results. Additionally, the logbook may contain descriptions of waste, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for documenting activities in field logbooks will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader (TL) – The TL is responsible for ensuring that the format and content of data entries are in accordance with this procedure. It is also the responsibility of the TL to communicate the need for any changes to/deviations from the SOP with the appropriate personnel, and document the change/deviation using a Libby Field Record of Modification Form.

Field Team Members – Field team members who make entries in field logbooks are required to read this procedure before engaging in this activity. Field team members will be assigned a field logbook prior to field activities and will be responsible for the care and maintenance of the logbook. Field team members will return field logbooks to the project file at the end of the assignment.

4.0 Equipment

The following is required for the proper completion of field logbooks:

- Logbook
- Indelible black or blue ink pen
- Ruler or similar scale

5.0 Procedures

5.1 Preparation

Commercially available, bound field logbooks with waterproof paper and lined, consecutively numbered pages will be used. Separate field logbooks will be kept for each field activity and the cover (some items may be recorded on the inside cover) of each field logbook shall clearly indicate:

- Field logbook sequence number
- Start date and end date of entries
- Title of document governing field activities
- Activity (if the logbook is to be activity-specific), site name, and location
- Contact name and phone number (typically the Project Manager)

For ongoing field activities that may span months or years, designated staff (e.g., field administrative staff) shall manage the field logbooks by tracking to whom and the date each field logbook was assigned, the general activities recorded in each field logbook, and the date the field logbook was returned to the project file.

The first two pages of the logbook will be reserved for a table of contents (TOC), and the third page will be reserved for abbreviations, acronyms, and definitions.

5.2 Operation

The following general requirements will apply when completing logbook entries for the Libby Site:

- Record equipment calibrations, work, observations, and quantities of materials, calculations, drawings, and related information directly in the logbook. If data collection forms are required by the governing document referencing this SOP, the information collected on the form does not need to be duplicated in the logbook. However, any forms used to record site information must be referenced in the logbook.
- Correct erroneous information recorded in a field logbook with a single line strikeout, initial, and date. The correct information will be entered in close proximity to the erroneous entry.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not remove any pages from the logbook.
- Document relinquishment of the logbook from one author to another (both parties must sign and date the transfer).
- Sign and date the final entry each day.
- When columns are used to organize information recorded on laboratory documents, the information recorded in the columns shall be identified in a column heading.

Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the logbook must reference the automatic data record or form.

At each location where a sample is collected or an observation or measurement made, a detailed description of the location is required and a sketch of the location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is toward the top of the page. Any maps, sketches, figures, or data that will not fit on a logbook page, or any separate forms or drawings (e.g., FSDS sheets, drawing markups) required by the governing document referencing this SOP should be referenced in the logbook.

Other events and observations that should be recorded include:

- Changes in weather or site conditions that impact field activities or have the potential to impact data collection (e.g., rain impacting air samples, upwind disturbances)
- Deviations from procedures outlined in any governing documents referencing this SOP, including the rationale and authorization for the deviation as appropriate
- Problems, downtime, or delays
- Visitors to the site

5.3 Post-operation

To guard against loss of data as a result of damage or disappearance of logbooks, completed pages and any supporting attachments shall be periodically photocopied (weekly, at a minimum) and maintained in the project file.

At the conclusion of each field activity or phase of site work, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated, that corrections were made properly, and that the cover information and TOC are complete. As field logbooks are completed, electronic copies may need to be posted to a project eRoom – refer to the governing document referencing this SOP for requirements. All original logbooks will be catalogued and maintained in the project file.

6.0 Restrictions/Limitations

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by governing agency personnel and their subcontractors. They are documents that may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these logbooks should be factual, clear, precise, and non-subjective. Field logbooks, and entries within, are not intended for personal use.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure consistency in recording information in field logbooks for Libby Site activities. Consistency will be achieved to the extent possible through proper training, use of designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require re-training of the field team members.

7.2 Field Checks

Field logbooks may be checked for completeness and adherence to SOP requirements on a daily basis by the TL for the first week of each field activity. These checks can be extended to once per month as field activities continue, and any errors noticed during the checks will be discussed with the author and corrected. If field activities continue beyond six months, the frequency of assessing field logbook entries will be established by the field Quality Assurance Manager.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 4-1, Field Logbook Content and Control, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Photographic Documentation of Field Activities

Prepared by: _____ Date: 4/12/12
CDM Smith

Approved by: _____ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

Photographic documentation, which includes still and digital photography and videotape or digital versatile/video disc (DVD) recordings, is an essential tool to document field activities conducted by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for photographic documentation. Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Arrows and Pointers – Used to indicate and/or draw attention to a special feature within the photograph.

Contrasting Backgrounds – Backdrops used to lay soil samples, cores, or other objects on for clearer viewing and to delineate features.

Data Recording Camera Back – A camera attachment or built-in feature that will record, at the very least, frame numbers and dates directly on the film. Digital cameras and recorders may also be equipped with a date stamping feature.

Identifier Component – Visual components used within a photograph such as visual slates, reference markers, and pointers.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Photographer – The camera operator (professional or amateur) for still photography, including digital photography, or videotape or DVD recording, whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

Reference Marker – A reference marker used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled

marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

Site – All buildings (if applicable) and land within the boundaries of the EPA's designated geounits, which may represent individual properties within the Libby Site, a collection of properties, or a larger geographical area.

Slates – Blank white index cards, paper, or a dry-erase board used to present information pertaining to the subject/procedure being photographed. Letters and numbers on the slate will be bold and written with black indelible marking pens.

2.2 Discussion

Photographs and videotape or DVD recordings made during field activities are used as an aid in documenting and describing site features, sample collection activities, equipment used, and conditions during the field activity being performed. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard reference markers, and pointers. These items shall become an integral part of the "visual media" that, for the purpose of this document, shall encompass still photographs, digital photographs, videotape recordings (or video footage), and recordings on DVDs. The use of a photographic logbook and standardized entry procedures are also outlined. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the visual media and ensure the representative nature of the photographic documentation.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for photographic documentation will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader (TL) – The TL is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The TL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographer – The photographer shall seek direction from the TL and regularly discuss the visual documentation requirements and schedule. The photographer may be responsible for maintaining a logbook or itemization of photos/recordings or providing captions. Specific requirements will be defined in the governing document referencing this SOP.

4.0 Equipment

The following equipment may be used for photographic documentation:

- 35-millimeter (mm) camera and appropriate film (e.g., medium speed or multi-purpose fine-grain color)
- Disposable, single-use camera (35mm or panoramic use)
- Digital camera
- Video camera and appropriate storage media (e.g., videotapes, DVDs)
- Extra batteries
- Standard reference markers
- Slates

- Arrows or pointers
- Contrasting backgrounds
- Logbook
- Data recording camera back (if available)
- Indelible black or blue ink pen
- Storage medium for digital camera

5.0 Procedures

5.1 Preparation

In addition to this SOP, photographers must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety (including requirements for personal protective equipment at a site), sample collection, equipment and personnel decontamination, documentation, etc. These procedures should be maintained on site by field staff at all times for easy reference.

The photographer should also be aware of any potential physical hazards while photographing the subject (e.g., traffic, operating equipment, low overhead hazard, edge of excavation area).

If required, a commercially available, bound logbook will be used to log and document photographic activities. Alternatively, a portion of the field logbook may be designated as the photographic log and documentation section.

Because digital cameras and DVD recorders have multiple photographic quality settings, if not specified in the governing document referencing this SOP, the TL shall specify the resolution (quality) at which photographic documentation should be collected. It should be noted that a camera or DVD recorder that obtains a higher resolution (quality) has a higher number of pixels and will store a fewer number of photographs per digital storage medium.

5.2 Operation

The following sections provide general guidelines that should be followed to visually document field activities and site features using still/digital cameras and video equipment. Slate and caption information will not be required at the Libby Site unless specified in the governing document referencing this SOP.

5.2.1 Still Photography

Slate Information

Each new roll of film or digital storage medium will contain on the first usable frame (for film) a slate with consecutively assigned control numbers (a unique, consecutive number that is assigned by the photographer).

Caption Information

Still photographs will have a full caption permanently attached to the back or permanently attached to a photo log sheet. Digital photographs should have a caption added after the photographs are downloaded. Unless modified by the governing document referencing this SOP, captions should contain the following information:

- Film roll control number (if required) and photograph sequence number
- Site name or location

- Description of activity/item shown
- Date and time
- Direction (if applicable)
- Photographer

Close-up and Feature Photography
Close-up photographs should include a standard reference marker of appropriate size as an indication of the feature size.

Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their *in situ* locations to enable a more accurate record of their initial condition and color for formal lithologic observations and interpretations.

Site Photography
Site photography, in general, consists predominantly of medium- and wide-angle shots. A standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane. While it is encouraged that a standard reference marker and caption/slate be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the logbook (field or photographic), photographic caption, or digital file name shall specify all information pertinent to the scene.

5.2.2 Photographic Documentation Using Video Cameras
As a reminder, it is not within the scope of this document to set appropriate guidelines for presentation or "show" videotape or DVD recording. The following guidelines are set for documentary videotape or DVD recordings only and should be implemented at the discretion of the site personnel.

Documentary videotape or DVD recordings of field activities may include an audio slate for all scenes, as directed by the governing document referencing this SOP. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account may include any additional information clarifying the subject matter being recorded.

A standard reference marker may be used when taking close-up shots of site features with a video camera. The scene may also include a caption/slate. It should be placed adjacent and parallel to the feature being photographed.

A standard reference marker and caption/slate may be included in all scenes, as directed by the governing document referencing this SOP. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original video recordings will not be edited. This will maintain the integrity of the information contained on the videotape or DVD. If editing is desired, a working copy of the original video recording can be made.

A label should be placed on the videotape or DVD with the appropriate identifying information (project name, project number, date, location, etc.).

5.2.3 Photographic Logs

Photographic activities shall be documented in a photographic log or in a section of the field logbook, as directed by the governing document referencing this SOP. The photographer will be responsible for making proper entries.

The following information shall be maintained in the appropriate logbook:

- Photographer name
- Roll/tape/DVD control number (as appropriate)
- Sequential tracking number for each photograph taken (for digital cameras, the camera-generated number may be used)
- Date and time (military time)
- Location
- Description of the activity/item photographed
- Description of the general setup, including approximate distance between the camera and the subject
- Other pertinent information to assist in the identification of the subject matter

5.3 Post-operation

5.3.1 Processing

All film will be sent for development and printing to a photographic laboratory (to be determined by the photographer). The photographer will be responsible for arranging transport of the film from the field to the photographic laboratory. The photographer will also be responsible for arranging delivery of the negatives and photographs, digital storage medium, or videotape or DVD to the TL to be placed in the project file.

Digital media should be downloaded daily to a personal computer or secure server; the files should be in either “JPEG” or “TIFF” format. Files should be renamed at the time of download in accordance with any file-naming conventions required by the governing document referencing this SOP, or to correspond to the logbook. At a minimum, the file name should include the corresponding sampling location and/or sample number and the photograph date (e.g., “123 Elm St_2-15-2011”, “AA-12345_3-18-2009”).

5.3.2 Documentation

At the end of each day’s photographic session, the photographer(s) will ensure that all photographic documentation has been maintained in accordance with this SOP.

5.3.2 Archive

Unless otherwise specified in Libby Site data management requirements or the governing document referencing this SOP, digital photographs will be stored on a secure server (with a nightly backup) or posted to a web-based location (e.g., an eRoom or SharePoint portal). These files will be archived until project closeout, at which time project management will determine a long-term electronic file storage system.

6.0 Restrictions/Limitations

This document is designed to provide a set of guidelines for the field personnel to ensure that an effective and standardized program of visual documentation is maintained.

The procedures outlined herein are general by nature. The photographer is responsible for specific operational activity or procedure. Questions concerning specific procedures or requirements should be directed to the TL.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure quality photographic documentation is gathered to support site activities. Consistency will be achieved to the extent possible through proper training, use of designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require re-training of the field team members.

7.2 Field Checks

Photographic documentation processes may be checked for completeness and adherence to SOP requirements on a daily basis by the TL for the first week of each field activity. These checks can be extended to once per month as field activities continue, and any errors noticed during the checks will be discussed with the photographer and corrected. If field activities continue beyond six months, the frequency of assessing photographic documentation will be established by the Quality Assurance Manager.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 4-2, Photographic Documentation of Field Activities, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Control of Measurement and Test Equipment

Prepared by: _____ Date: 4/12/12
CDM Smith

Approved by: _____ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for the control of measurement and test equipment (M&TE) used by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Traceability – The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

2.2 Discussion

M&TE may be government furnished (GF), rented or leased from an outside vendor, or purchased. It is essential that measurements and tests resulting from the use of equipment be of the highest accountability and integrity. To facilitate that, the equipment shall be used in full understanding and compliance with the instructions and specifications included in the manufacturer's operations and maintenance and calibration procedures, and in accordance with any other related requirements specified in the governing document referencing this SOP.

3.0 Responsibilities

All staff with responsibility for the direct control and/or use of M&TE is responsible for being knowledgeable of, and understanding and implementing the requirements contained herein, as well as any additional related requirements.

Team Leader (TL) – Responsible for identifying the technical specifications (e.g., precision, accuracy) for M&TE needed to meet project data collection objectives, and determining any

additional applicable Libby Site-specific requirements (e.g., periodic calibration of primary calibration sources) for M&TE.

Requisitioner – Responsible for ensuring M&TE is obtained or procured that meets the technical specifications identified by the TL, and facilitates obtaining the manufacturer's operations and maintenance and calibration procedures prior to field work.

Receiver – Responsible for receipt and/or unpackaging of M&TE and notifying the TL that the item has been received.

User – Responsible for the proper preparation and use of M&TE to collect the quality and quantity of data needed to meet project objectives. Users are typically field team members.

4.0 Equipment

Required M&TE will be specified in the governing document referencing this SOP.

5.0 Procedures

The following general requirements apply to M&TE at the Libby Site. Additional details and responsibilities are described later in this section.

- Manufacturer maintenance and calibration procedures must be followed when using M&TE
- Obtain the maintenance and calibration procedures if they are missing or incomplete
- Attach or include the maintenance and calibration procedures with the M&TE
- Prepare and record maintenance and calibration in an equipment or field log according to requirements stated in the governing document referencing this SOP
- Maintain M&TE records
- Label M&TE requiring routine or scheduled calibration (when required)
- Perform maintenance and calibration using the appropriate procedure and calibration standards
- Identify and take action on nonconforming M&TE

5.1 Preparation

5.1.1 Obtain the Operating, Maintenance, and Calibration Documents

For Procured M&TE

Requisitioner – Specify that the maintenance and calibration procedures be included.

For GF M&TE Acquired as a Result of Property Transfer

TL – Inspect the M&TE to determine whether maintenance and calibration procedures are included with the item. If missing or incomplete, obtain the appropriate documentation from the manufacturer.

For Rented or Leased M&TE

Requisitioner – Specify that the maintenance and calibration procedures, the latest calibration record, and the calibration standards certification be included. If this information is not delivered with the M&TE, request it from the vendor.

5.1.2 Prepare and Record Maintenance and Calibration Records

For All M&TE

Receiver – Upon receipt of an item of M&TE, notify the TL for the overall property control of the equipment.

TL and User – Record all maintenance and calibration events in an equipment or field log. The log must have sequentially-numbered pages.

5.2 Operation

TL and User – Operate, maintain, and calibrate M&TE in accordance with the maintenance and calibration procedures. Record maintenance and calibration actions in the equipment log or field log.

5.2.2 Traceability of Calibration Standards

For All M&TE

TL and User –

- When ordering calibration standards, request nationally recognized standards as specified or required. Request commercially available standards when not otherwise specified or required. Or, request standards in accordance with other related project-specific requirements.
- Require certifications for standards that clearly state the traceability.
- Require Material Safety Data Sheets to be provided with standards.
- Note standards that are perishable and consume or dispose of them on or before the expiration date.

5.2.3 M&TE That Fails Calibration

For any M&TE item that cannot be calibrated or adjusted to perform accurately:

User – Immediately discontinue use and segregate the item from other equipment.

TL – Review the current and previous maintenance and calibration records to determine if the validity of current or previous measurement and test results could have been affected and notify the appropriate authorities (typically the Project Manager) of the results. Any test results that are known to impact or have the potential to impact project data will be documented using a Libby Field Record of Modification Form.

5.3 Post-operation

M&TE shall be promptly returned to the owner at the end of field activities. All operations, maintenance, and calibration procedures shall be retained with the M&TE. Project M&TE records (e.g., equipment logs) will be retained in the project file.

6.0 Restrictions/Limitations

On an item-by-item basis, exemptions from the requirements of this SOP may be granted by the Health and Safety Manager and/or Quality Assurance Manager. All exemptions shall be documented by the grantor and included in the equipment records as appropriate.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes. Every effort will be made to ensure the appropriate and functional M&TE are used to support site activities. This will be achieved to the extent possible through proper training, use of qualified procurement and designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require discussion with appropriate management and, as appropriate, re-training of the field team members. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 5-1, Control of Measurement and Test Equipment, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Field Equipment Decontamination

Prepared by: _____ Date: 4/12/12
CDM Smith

Approved by: _____ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants off site. The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for the decontamination of field equipment used by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Definitions

Clean – Free of contamination and when decontamination has been completed in accordance with this SOP.

Cross contamination – The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or non-contaminated samples or areas.

Decontamination – The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure of personnel.

De-mineralized water – Water that has had most to all minerals removed from it. De-mineralized water shall only be stored in clean glass, stainless steel, or plastic containers that can be closed when not in use.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Material Safety Data Sheet (MSDS) – Document that discusses the proper storage and physical and toxicological characteristics of a particular substance used during field operations. MSDSs are to be maintained on site at all times during field operations.

Potable water – Tap water may be obtained from any municipal system. Chemical analysis of the water source may be required before it is used.

Sampling equipment – Equipment that comes into direct contact with the sample media. Such equipment includes split spoon samplers, well casing and screens, and trowels or bowls used to collect and/or homogenize samples.

Soap – Low-sudsing, non-phosphate detergent (e.g., Liquinox®).

Solvent rinse – Pesticide-grade (or better) isopropanol, acetone, or methanol.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for field equipment decontamination will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader - The TL is responsible for ensuring that field personnel are properly trained and that decontamination is conducted in accordance with this procedure and any other pertinent Libby Site decontamination processes cited in the governing document referencing this SOP.

Field Team Members – Field team members performing operations on the Libby Site are responsible for adhering to the procedures contained in this SOP and any other decontamination processes specified in the governing document referencing this SOP. If required, field team members will collect and document rinsate samples (also known as equipment blanks) to provide quantitative verification that these procedures have been correctly implemented. Field team members are also responsible for communicating any problems pertaining to the decontamination of field equipment to the TL.

4.0 Equipment

The following equipment may be employed wholly or in part during use of this SOP (refer to the governing document referencing this SOP for detailed requirements):

- Stiff-bristle scrub brushes
- Plastic buckets, scoops, trowels, and troughs
- Soap
- Nalgene® or Teflon® sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayers (pump sprayer material must be compatible with the solution used)
- Plastic sheeting, plastic bags, and/or aluminum foil to keep decontaminated equipment clean between uses
- Disposable wipes, rags, or paper towels
- Potable water (potable water may be required to be tested for contaminants before use)
- De-mineralized water
- Gloves, safety glasses, and other protective clothing as specified in the health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source

- Tools for equipment assembly and disassembly
- 55-gallon drums or tanks for temporary storage of decontamination water
- Pallets for drums or tanks holding decontamination water

5.0 Procedures

All reusable equipment (non-dedicated) used to collect, handle, or measure samples shall be decontaminated before coming into contact with any sample media or personnel using the equipment. Decontamination of equipment shall occur either at a specified location, central decontamination station or at portable decontamination stations set up at the sampling location, drill site, or monitoring well location. The centrally-located decontamination area may include an appropriately-sized bermed and lined area on which equipment decontamination occurs and equipped with a collection system and/or storage vessels. In certain circumstances, berming may not be necessary when small quantities of water are being generated and for some short duration field activities. Equipment shall be transported to and from the decontamination area in a manner to prevent cross contamination of equipment and/or the area.

Typically at the Libby Site, decontamination water will not be captured and will be discharged to the ground at the site. However, the exact procedure for decontamination waste disposal may be discussed in the governing document referencing this SOP. Also, solvent rinse fluids may need to be segregated from other investigation-derived waste (IDW).

All items that come into contact with potentially contaminated media shall be decontaminated before use, between sampling locations (does not need to be performed between aliquots of an individual sample) and/or drilling locations, and after use. All decontamination procedures for the equipment being used are provided in the following sections.

General Guidelines

- Potable or de-mineralized water shall be free of all contaminants of concern. Depending upon the governing document referencing this SOP, analytical data from the water source may be required to ensure it is clean.
- Sampling equipment that has come into contact with oil and grease shall be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or Libby Site-specific requirements regarding solvent use shall be stated in the governing document referencing this SOP.
- All solvents[1] shall be pesticide-grade or better and traceable to a source. The corresponding lot numbers shall be recorded in the appropriate field logbook.
- Decontaminated equipment shall be allowed to air dry before being used.
- Documentation of all equipment, including type of equipment, date, time, method of decontamination, and any associated field quality control sampling, shall be recorded in the field logbook.

[1]Solvents are potentially hazardous materials and must be handled, stored, and transported accordingly. Solvents shall never be used in a closed building. See the investigation-specific health and safety plan and/or the chemical's MSDS for specific information regarding the safe use of the chemical.

- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment shall be used as specified in the governing document referencing this SOP and/or health and safety plan.

5.1 Heavy Equipment Decontamination

Heavy equipment typically used at the Libby Site includes drilling rigs, trucks, and excavators. For any heavy equipment used during EPA response actions, the equipment decontamination procedures provided in the current version of the Libby Asbestos Site Response Action Work Plan shall apply. For all other field activities, follow these steps when decontaminating heavy equipment:

1. Establish a bermed decontamination area that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be used; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads shall be upwind of the investigation area(s).
2. With the heavy equipment in place, spray areas (rear of rig or backhoe) exposed to contaminated media by pressurized means. Be sure to spray down all surfaces, including the undercarriage.
3. Use brushes, soap, and appropriate decontamination water to remove dirt whenever necessary.
4. Remove equipment from the decontamination pad.
5. After decontamination activities are completed, collect all plastic sheeting, and disposable gloves, boots, and clothing in containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the governing document referencing this SOP.

5.2 Downhole Equipment Decontamination

Downhole equipment includes hollow-stem augers, drill pipes, rods, and stems. Follow these steps when decontaminating this equipment:

1. Set up a centralized decontamination area, if possible. This area shall be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.
2. Set up a “clean” area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination areas shall be upwind of any areas under investigation.
3. Using soap and appropriate water with pressurization (e.g., Hudson® sprayer), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.
4. If using soapy water, rinse the equipment using clean appropriate water with pressurization.
5. Remove the equipment from the decontamination area and place in a clean area upwind to air dry.
6. After decontamination activities are completed, collect all plastic sheeting, and disposable gloves, boots, and clothing in containers or receptacles. All receptacles containing

contaminated items must be properly labeled for disposal as detailed in the governing document referencing this SOP.

5.3 Sampling Equipment Decontamination

Follow these steps when decontaminating sampling equipment:

1. Set up a decontamination line. The decontamination line shall progress from "dirty" to "clean." A clean area shall be established upwind of the decontamination wash/rinse activities to dry the equipment.
2. Disassemble any items that may trap contaminants internally. Do not reassemble the items until decontamination and air drying are complete.
3. Wash the items with appropriate water and soap using a stiff brush as necessary to remove particulate matter and surface films. With the exception of polyvinyl chloride or plastic items, the items may be steam-cleaned using soap and hot water as an alternative to brushing. Items that have come into contact with concentrated and/or oily contaminants may need to be rinsed with a solvent such as hexane and allowed to air dry prior to this washing step.
4. Thoroughly rinse the items with potable water.
5. If sampling for organic compounds, thoroughly rinse the items with solvent (e.g., isopropanol) followed by a rinse using de-mineralized water. The specific chemicals used for the solvent rinse phase shall be specified in the work plan. Solvents are potentially hazardous materials and care must be exercised when using these chemicals to prevent adverse health effects. Appropriate personal protective equipment (PPE) must be worn when using these chemicals. These chemicals (including spent rinsate) must be managed and stored appropriately. Special measures such as proper labels, paperwork, notification, etc. may be required when transporting or shipping solvent chemicals.
6. Rinse the items thoroughly using de-mineralized water.
7. Allow the items to air dry completely.
8. After decontamination activities are completed, collect all plastic sheeting, and disposable PPE. Place the contaminated items in properly labeled bags or containers for disposal. Refer to the governing document referencing this SOP for labeling and waste management requirements.

5.4 Pump Decontamination

Follow the manufacturer’s recommendation for specified pump decontamination procedures. At a minimum, follow these steps when decontaminating pumps:

1. Set up the decontamination area and separate “clean” storage area using plastic sheeting to cover the ground, tables, and other surfaces. Set up three containers: the first container shall contain dilute (non-foaming) soapy water; the second container shall contain potable water; and the third container shall contain de-mineralized water.
2. The pump shall be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first container. Pump soapy water through the pump assembly. Scrub the outside of the pump and other wetted parts with a metal brush.

3. Move the pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.
4. Move the pump intake to the de-mineralized water container. Pump the water through the pump assembly. Pump the volume of water through the pump specified in the field plan. Usually, three pump-and-line-assembly volumes shall be required.
5. Remove the decontaminated pump assembly to the clean area and allow it to air dry upwind of the decontamination area. Intake and outlet orifices shall be covered to prevent the entry of airborne contaminants and particles.

5.5 Instrument Probe Decontamination

Instrument probes used for field measurements (e.g., pH meters, conductivity meters) shall be decontaminated between samples and after use with de-mineralized water. At no time shall a sample probe be placed in contact with water within a sample container.

5.6 Waste Disposal

Waste disposal should follow the requirements listed in Libby project-specific SOP for handling investigation-derived waste (IDW) and the governing document referencing this SOP. The following are guidelines for disposing of waste:

- Decontamination water will typically not be captured, packaged, labeled, or stored as IDW at the site. Decontamination water will be discharged to the ground at the work site. Other materials used in the decontamination process will be disposed of as IDW.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.
- If large quantities of used decontamination solutions shall be generated, each type of waste shall be segregated in separate containers.
- Plastic sheeting and disposable protective clothing will be treated and disposed of as asbestos-containing materials.

6.0 Restrictions/Limitations

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow. Check with EPA Region 8 and the State of Montana for approved decontamination solvents.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure proper field equipment decontamination, which will be achieved to the extent possible through proper training, use of designated field staff, and

provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require staff re-training.

7.2 Field Checks

Adherence to field equipment decontamination requirements may be checked on a daily basis by the TL for the first week of each field activity. These checks can be extended to once per month as field activities continue, and any non-compliance discussed with the field team member. If field activities continue beyond six months, the frequency of assessing field equipment decontamination will be established by the field Quality Assurance Manager.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 4-5, Field Equipment Decontamination, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Field Equipment Decontamination

Prepared by: _____ Date: 4/12/12
CDM Smith

Approved by: _____ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants off site. The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for the decontamination of field equipment used by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Definitions

Clean – Free of contamination and when decontamination has been completed in accordance with this SOP.

Cross contamination – The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or non-contaminated samples or areas.

Decontamination – The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure of personnel.

De-mineralized water – Water that has had most to all minerals removed from it. De-mineralized water shall only be stored in clean glass, stainless steel, or plastic containers that can be closed when not in use.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Material Safety Data Sheet (MSDS) – Document that discusses the proper storage and physical and toxicological characteristics of a particular substance used during field operations. MSDSs are to be maintained on site at all times during field operations.

Potable water – Tap water may be obtained from any municipal system. Chemical analysis of the water source may be required before it is used.

Sampling equipment – Equipment that comes into direct contact with the sample media. Such equipment includes split spoon samplers, well casing and screens, and trowels or bowls used to collect and/or homogenize samples.

Soap – Low-sudsing, non-phosphate detergent (e.g., Liquinox®).

Solvent rinse – Pesticide-grade (or better) isopropanol, acetone, or methanol.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for field equipment decontamination will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader - The TL is responsible for ensuring that field personnel are properly trained and that decontamination is conducted in accordance with this procedure and any other pertinent Libby Site decontamination processes cited in the governing document referencing this SOP.

Field Team Members – Field team members performing operations on the Libby Site are responsible for adhering to the procedures contained in this SOP and any other decontamination processes specified in the governing document referencing this SOP. If required, field team members will collect and document rinsate samples (also known as equipment blanks) to provide quantitative verification that these procedures have been correctly implemented. Field team members are also responsible for communicating any problems pertaining to the decontamination of field equipment to the TL.

4.0 Equipment

The following equipment may be employed wholly or in part during use of this SOP (refer to the governing document referencing this SOP for detailed requirements):

- Stiff-bristle scrub brushes
- Plastic buckets, scoops, trowels, and troughs
- Soap
- Nalgene® or Teflon® sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayers (pump sprayer material must be compatible with the solution used)
- Plastic sheeting, plastic bags, and/or aluminum foil to keep decontaminated equipment clean between uses
- Disposable wipes, rags, or paper towels
- Potable water (potable water may be required to be tested for contaminants before use)
- De-mineralized water
- Gloves, safety glasses, and other protective clothing as specified in the health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source

- Tools for equipment assembly and disassembly
- 55-gallon drums or tanks for temporary storage of decontamination water
- Pallets for drums or tanks holding decontamination water

5.0 Procedures

All reusable equipment (non-dedicated) used to collect, handle, or measure samples shall be decontaminated before coming into contact with any sample media or personnel using the equipment. Decontamination of equipment shall occur either at a specified location, central decontamination station or at portable decontamination stations set up at the sampling location, drill site, or monitoring well location. The centrally-located decontamination area may include an appropriately-sized bermed and lined area on which equipment decontamination occurs and equipped with a collection system and/or storage vessels. In certain circumstances, berming may not be necessary when small quantities of water are being generated and for some short duration field activities. Equipment shall be transported to and from the decontamination area in a manner to prevent cross contamination of equipment and/or the area.

Typically at the Libby Site, decontamination water will not be captured and will be discharged to the ground at the site. However, the exact procedure for decontamination waste disposal may be discussed in the governing document referencing this SOP. Also, solvent rinse fluids may need to be segregated from other investigation-derived waste (IDW).

All items that come into contact with potentially contaminated media shall be decontaminated before use, between sampling locations (does not need to be performed between aliquots of an individual sample) and/or drilling locations, and after use. All decontamination procedures for the equipment being used are provided in the following sections.

General Guidelines

- Potable or de-mineralized water shall be free of all contaminants of concern. Depending upon the governing document referencing this SOP, analytical data from the water source may be required to ensure it is clean.
- Sampling equipment that has come into contact with oil and grease shall be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or Libby Site-specific requirements regarding solvent use shall be stated in the governing document referencing this SOP.
- All solvents[1] shall be pesticide-grade or better and traceable to a source. The corresponding lot numbers shall be recorded in the appropriate field logbook.
- Decontaminated equipment shall be allowed to air dry before being used.
- Documentation of all equipment, including type of equipment, date, time, method of decontamination, and any associated field quality control sampling, shall be recorded in the field logbook.

[1]Solvents are potentially hazardous materials and must be handled, stored, and transported accordingly. Solvents shall never be used in a closed building. See the investigation-specific health and safety plan and/or the chemical's MSDS for specific information regarding the safe use of the chemical.

- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment shall be used as specified in the governing document referencing this SOP and/or health and safety plan.

5.1 Heavy Equipment Decontamination

Heavy equipment typically used at the Libby Site includes drilling rigs, trucks, and excavators. For any heavy equipment used during EPA response actions, the equipment decontamination procedures provided in the current version of the Libby Asbestos Site Response Action Work Plan shall apply. For all other field activities, follow these steps when decontaminating heavy equipment:

1. Establish a bermed decontamination area that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be used; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads shall be upwind of the investigation area(s).
2. With the heavy equipment in place, spray areas (rear of rig or backhoe) exposed to contaminated media by pressurized means. Be sure to spray down all surfaces, including the undercarriage.
3. Use brushes, soap, and appropriate decontamination water to remove dirt whenever necessary.
4. Remove equipment from the decontamination pad.
5. After decontamination activities are completed, collect all plastic sheeting, and disposable gloves, boots, and clothing in containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the governing document referencing this SOP.

5.2 Downhole Equipment Decontamination

Downhole equipment includes hollow-stem augers, drill pipes, rods, and stems. Follow these steps when decontaminating this equipment:

1. Set up a centralized decontamination area, if possible. This area shall be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.
2. Set up a “clean” area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination areas shall be upwind of any areas under investigation.
3. Using soap and appropriate water with pressurization (e.g., Hudson® sprayer), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.
4. If using soapy water, rinse the equipment using clean appropriate water with pressurization.
5. Remove the equipment from the decontamination area and place in a clean area upwind to air dry.
6. After decontamination activities are completed, collect all plastic sheeting, and disposable gloves, boots, and clothing in containers or receptacles. All receptacles containing

contaminated items must be properly labeled for disposal as detailed in the governing document referencing this SOP.

5.3 Sampling Equipment Decontamination

Follow these steps when decontaminating sampling equipment:

1. Set up a decontamination line. The decontamination line shall progress from "dirty" to "clean." A clean area shall be established upwind of the decontamination wash/rinse activities to dry the equipment.
2. Disassemble any items that may trap contaminants internally. Do not reassemble the items until decontamination and air drying are complete.
3. Wash the items with appropriate water and soap using a stiff brush as necessary to remove particulate matter and surface films. With the exception of polyvinyl chloride or plastic items, the items may be steam-cleaned using soap and hot water as an alternative to brushing. Items that have come into contact with concentrated and/or oily contaminants may need to be rinsed with a solvent such as hexane and allowed to air dry prior to this washing step.
4. Thoroughly rinse the items with potable water.
5. If sampling for organic compounds, thoroughly rinse the items with solvent (e.g., isopropanol) followed by a rinse using de-mineralized water. The specific chemicals used for the solvent rinse phase shall be specified in the work plan. Solvents are potentially hazardous materials and care must be exercised when using these chemicals to prevent adverse health effects. Appropriate personal protective equipment (PPE) must be worn when using these chemicals. These chemicals (including spent rinsate) must be managed and stored appropriately. Special measures such as proper labels, paperwork, notification, etc. may be required when transporting or shipping solvent chemicals.
6. Rinse the items thoroughly using de-mineralized water.
7. Allow the items to air dry completely.
8. After decontamination activities are completed, collect all plastic sheeting, and disposable PPE. Place the contaminated items in properly labeled bags or containers for disposal. Refer to the governing document referencing this SOP for labeling and waste management requirements.

5.4 Pump Decontamination

Follow the manufacturer’s recommendation for specified pump decontamination procedures. At a minimum, follow these steps when decontaminating pumps:

1. Set up the decontamination area and separate “clean” storage area using plastic sheeting to cover the ground, tables, and other surfaces. Set up three containers: the first container shall contain dilute (non-foaming) soapy water; the second container shall contain potable water; and the third container shall contain de-mineralized water.
2. The pump shall be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first container. Pump soapy water through the pump assembly. Scrub the outside of the pump and other wetted parts with a metal brush.

3. Move the pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.
4. Move the pump intake to the de-mineralized water container. Pump the water through the pump assembly. Pump the volume of water through the pump specified in the field plan. Usually, three pump-and-line-assembly volumes shall be required.
5. Remove the decontaminated pump assembly to the clean area and allow it to air dry upwind of the decontamination area. Intake and outlet orifices shall be covered to prevent the entry of airborne contaminants and particles.

5.5 Instrument Probe Decontamination

Instrument probes used for field measurements (e.g., pH meters, conductivity meters) shall be decontaminated between samples and after use with de-mineralized water. At no time shall a sample probe be placed in contact with water within a sample container.

5.6 Waste Disposal

Waste disposal should follow the requirements listed in Libby project-specific SOP for handling investigation-derived waste (IDW) and the governing document referencing this SOP. The following are guidelines for disposing of waste:

- Decontamination water will typically not be captured, packaged, labeled, or stored as IDW at the site. Decontamination water will be discharged to the ground at the work site. Other materials used in the decontamination process will be disposed of as IDW.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.
- If large quantities of used decontamination solutions shall be generated, each type of waste shall be segregated in separate containers.
- Plastic sheeting and disposable protective clothing will be treated and disposed of as asbestos-containing materials.

6.0 Restrictions/Limitations

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow. Check with EPA Region 8 and the State of Montana for approved decontamination solvents.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure proper field equipment decontamination, which will be achieved to the extent possible through proper training, use of designated field staff, and

provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require staff re-training.

7.2 Field Checks

Adherence to field equipment decontamination requirements may be checked on a daily basis by the TL for the first week of each field activity. These checks can be extended to once per month as field activities continue, and any non-compliance discussed with the field team member. If field activities continue beyond six months, the frequency of assessing field equipment decontamination will be established by the field Quality Assurance Manager.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 4-5, Field Equipment Decontamination, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Handling Investigation-derived Waste

Prepared by: _____ Date: 4/12/12
CDM Smith

Approved by: _____ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for handling investigation-derived waste (IDW) resulting from work performed by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Hazardous Waste – Discarded material that is regulated listed waste, or waste that exhibits ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.3 or state regulations.

Investigation-derived Waste (IDW) – Discarded materials resulting from field activities such as sampling, surveying, drilling, excavation, and decontamination processes that, in present form, possess no inherent value or additional usefulness without treatment.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Site – All buildings (if applicable) and land within the boundaries of the EPA's designated geounits, which may represent individual properties within the Libby Site, a collection of properties, or a larger geographical area.

Treatment, Storage, and Disposal Facility (TSDF) – Permitted facilities that accept hazardous waste shipments for further treatment, storage, and/or disposal. These facilities must be permitted by the EPA and appropriate state and local agencies.

2.2 Discussion

At the Libby Site, field investigation and response action activities may result in the generation of IDW. IDW may include soil and cuttings from test pits or well installation; soil and other materials from the collection of samples; personal protective equipment (PPE); and other wastes or supplies used during the sampling and testing of potentially hazardous materials.

The vast majority of Libby Site IDW is expected to relate to the contaminant of concern – Libby amphibole asbestos. The overall management of IDW must comply with applicable regulatory requirements.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for handling IDW will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader (TL) – The TL is responsible for identifying Libby Site-specific requirements for the disposal of IDW in accordance with federal, state, and/or facility requirements, and ensuring that all IDW procedures are conducted in accordance with this SOP. The TL will communicate with the field team members regarding the specific objectives and anticipated situations that require deviation from this SOP.

Field Team Members – Field team members are responsible for adhering to the procedures contained in this SOP, and communicating any unusual or unplanned condition to the TL.

4.0 Equipment

Equipment required for IDW containment may vary according to field activity requirements. Management decisions concerning the necessary equipment required shall consider containment method, sampling, labeling, maneuvering, and storage (if applicable). Equipment must be onsite and inspected before commencing work.

4.1 IDW Containment Devices

The appropriate containment device (e.g., bags, drums, tanks, etc.) and the ultimate disposition of the IDW shall be specified in the governing document referencing this SOP. Typical IDW containment devices include:

- Plastic sheeting (polyethylene) with a minimum thickness of 6 mil
- U.S. Department of Transportation (DOT)-approved steel containers
- Polyethylene or steel bulk storage tanks

The volume of the appropriate containment device shall be specified in the governing document referencing this SOP.

4.2 IDW Container Labeling

A “Waste Container” or “IDW Container” label or indelible marking shall be applied to each container. Labeling or marking requirements for onsite IDW not expected to be transported offsite are as detailed below.

- Labels and markings must contain the following information: project name, generation date, location of waste origin, container identification number, sample number (if applicable), and contents.

- Each label or marking will be applied to the upper one-third of the container at least twice, on opposite sides.

- Containers that are 5 gallons or less may only require one label or set of markings.

- Labels or markings will be positioned on a smooth part of the container. The label must not be affixed across container bungs, seams, ridges, or dents.

- Labels must be constructed of a weather-resistive material with markings made with a permanent marker or paint pen and capable of enduring the expected weather conditions. If markings are used, the color must be easily distinguishable from the container color.

- Labels will be secured in a manner to ensure that they remain affixed to the container.

Labeling or marking requirements for IDW expected to be transported off of the work site must be in accordance with the requirements of 29 CFR 1926.1101.

4.3 IDW Container Movement
Staging areas for IDW containers shall be predetermined and in accordance with investigation-specific requirements. Arrangements shall be made before field mobilization as to the methods and personnel required to safely transport IDW containers to the staging area. Transportation of IDW containers offsite via a public roadway is prohibited unless 49 CFR 172 requirements are met.

4.4 IDW Container Storage
Containerized IDW awaiting results of pending chemical analysis or further onsite treatment shall be staged on site. Staging areas and bulk storage procedures are to be determined according to investigation-specific requirements. Containers are to be stored in such a fashion that the labels can be easily read. A secondary/spill container must be provided for liquid IDW storage and as appropriate for solid IDW storage (e.g., steel drums shall not be stored in direct contact with the ground).

5.0 Procedures
The three general options for managing IDW are: 1) collection and onsite disposal; 2) collection for offsite disposal; and 3) collection and interim management. The option selected shall take into account the following factors:

- Type (soil, sludge, liquid, debris), quantity, and source of IDW
- Risk posed by managing the IDW onsite
- Compliance with regulatory requirements
- IDW minimization and consistency with the Libby Site remedy

5.1 Collection and Onsite Disposal
5.1.1 Soil/Sludge/Sediment
Unless otherwise specified in the governing document referencing this SOP, when handling soil/sludge/sediment IDW at the Libby Site, the following will apply:

- Return IDW to boring, pit, or source immediately after generation as long as returning the media to these areas will not increase site risks (i.e., the contaminated soil will not be in a different area or at a different depth than from where it was originally obtained).

5.1.2 Aqueous Liquids

Unless otherwise specified in the governing document referencing this SOP, options for handling aqueous liquid IDW at the Libby Site are listed below. These options may require results of laboratory analysis to obtain client and/or regulatory approval.

- Discharge to ground surface close to the well from which it was extracted, only if soil contaminants will not be mobilized in the process and the action will not contaminate clean areas. If IDW from the sampling of background up-gradient wells is not a community concern or associated with soil contamination, this presumably uncontaminated IDW may be released on the ground around the well.
- When small amounts (i.e., less than 5 gallons) of used decontamination fluids are generated during site characterization activities (e.g., during soil sampling), the fluids may be discharged to the ground surface within the sampling area or allowed to evaporate from an open bucket.

5.1.3 Disposable PPE

Disposable PPE IDW (not including excess soil volume) for the Libby Site will be collected in garbage bags and marked “IDW” with an indelible ink marker. These bags will be deposited into the asbestos-containing material (ACM) waste stream for appropriate disposal at the local Class IV asbestos landfill. Excess soil volume will be returned to the area from where it was collected.

5.2 Collection and Interim Management

Collection and interim management options that may be employed for Libby Site IDW are provided herein.

Storing IDW onsite until the final action may be practical in the following situations:

- Returning wastes (especially sludges and soils) to their onsite source area would require re-excavation for disposal as determined for the final site remedy.
- Interim storage in containers may be necessary to provide adequate protection to human health and the environment.
- Storing IDW until the final disposal of all wastes from the site will eliminate the need to address this issue more than once.
- Interim storage may be necessary to provide time for sampling and analysis.

6.0 Restrictions/Limitations

Managers of the site shall determine the most appropriate disposal option for IDW an activity-specific basis. Parameters to consider, especially when determining the level of protection, include: the volume of IDW and the nature of contaminants present in the site soil. Special disposal/handling may be needed for drilling fluids because they may contain significant solid components and therefore may need to be handled, treated, and disposed as non-liquid waste. Disposable sampling materials, disposable PPE, decontamination fluids, etc. will always be

managed on a site-specific basis. Under no circumstances shall these types of materials be stored in a site office, facility, or warehouse.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure proper handling of IDW, which will be achieved to the extent possible through proper training, use of designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require staff re-training.

7.2 Field Checks

Adherence to requirements for handling IDW may be checked on a daily basis by the TL (or their designate) for the first week of each field activity. These checks can be extended to once per month as field activities continue. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require field team member re-training. If field activities continue beyond six months, the frequency of assessing field logbook entries will be established by the field Quality Assurance Manager or their designate.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 2-2, Guide to Handling Investigation-derived Waste, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Sample Custody

Prepared by: _____ Date: 4/12/12
CDM Smith

Approved by: _____ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
0	4/12/12	--

1.0 Objective

Sample custody procedures are integral to maintaining and documenting the possession of environmental samples collected by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for sample custody for the Libby Site. Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Chain-of-custody record (COC) – Used to document the custody, control, transfer, analysis, and disposition of samples.

Custody seal – An adhesive-backed seal that is applied to an individual sample or sample container to demonstrate that sample integrity has not been compromised during sample transfer.

Facility – A designated sample processing facility, analytical laboratory, or long-term storage area, for Libby Site samples.

Field sample data sheet (FSDS) – A controlled document used to record sample information.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Sample – Material to be analyzed that is contained in single or multiple containers representing a unique sample number.

Sample custody – The possession or safe-keeping of samples in such a manner that prevents tampering, damage, or loss.

Sample labels – Adhesive-backed labels that contain, at a minimum, the unique sample number/identifier. Sample labels are typically used on field documentation, sample cassettes, and containers, and may be pre-printed to minimize sequencing or transcription errors.

2.2 Discussion

Because of the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures must be followed.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for the custody of samples will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader (TL) – Responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events.

Sampler – Responsible for the care and custody of samples from the time of collection until they are transferred.

Field Sample Coordinator (FSC) – Responsible for accepting samples into their custody from the sampler(s), producing COCs, and relinquishing or shipping samples to the appropriate facility.

Laboratory Coordinator (LC) – Responsible for coordinating the preparation and/or analysis of Libby Site samples with project facilities in order to achieve requested turnaround times for analytical data.

4.0 Equipment

Depending upon staff responsibility, the following equipment will be employed during use of this SOP:

- Field logbook
- FSDSs
- Indelible blue or black ink pens
- Sample labels
- Zip-top plastic bags
- Custody seals
- Container(s) in which to keep/protect samples

5.0 Procedures

5.1 Preparation

Communications between the TL, sampler(s), the FSC, the LC are critical to ensure the efficient throughput of samples to meet project data objectives. As such, an FSC will attend all field planning meetings to gather information about sampling events (e.g., sample quantities, special sample handling, processing, or analysis concerns, and requested turnaround times). For long-term field programs, sampling staff will notify the FSC daily of the estimated number and type of samples to be collected. In either case, the FSC will relay the pertinent investigation-specific information to the LC, who will, in turn, coordinate preparation and/or analysis with project facilities. On an as-needed basis (typically daily during the field season), the FSC will schedule meetings in which to relinquish samples to the LC.

5.2 Operation

A sample is under custody if it is: 1) in your possession, 2) in your view after being in your possession, 3) in your possession and you locked it up, or 4) in a designated secure area. The following procedures detail the process used to maintain the custody of each Libby Site sample. Note that if at any point samples are left unattended or receipt of samples is refused, this must be documented in the field logbook or on the COC, as appropriate.

5.2.1 Sampler Custody

Sample custody begins at the time of sample collection and will be maintained using a field logbook and FSDSs to document pertinent sample-related information. Samples will be placed in safe areas where they are protected from tampering, damage, or loss. Following sample collection, custody seals will be used as an indicator of tampering. Samples will remain in the sampler's possession, within sight, or in a secure area (e.g., locked vehicle) until the sample is relinquished.

For samples collected using zip-top bags as the primary container, all samples will be double-bagged and custody sealed on the outer bag by the sampler. For samples collected using cassettes, the cassette will be custody sealed so that both end caps of the sampling cassette are covered but sample labels or identifiers are not obstructed. The cassette will then be placed in a zip-top bag.

Sampler(s) may be required to transfer custody of samples directly to an FSC or a designated secure sample storage location, or to hand deliver or ship samples to a facility – refer to the governing document referencing this SOP for specifics. Project-specific SOP EPA-LIBBY-2012-07, *Packaging and Shipping Environmental Samples*, will be followed for samples that are required to be shipped.

If relinquishing to an FSC or secure storage area, the sampler will note in the field logbook the time of transfer, and the name and company affiliation of the receiver or dedicated storage location. Completed and quality-checked FSDSs will accompany the samples.

5.2.2 FSC Custody

Upon receipt of samples and accompany FSDSs, the FSC will verify that:

- Each FSDS is complete
- Each sample is accounted for
- Soil samples are double-bagged
- Each cassette is sealed in its own zip-top bag and caps on cassettes are in place
- Sample containers (e.g., bags, bottles) are tightly sealed
- Custody seals are correctly and securely placed on each sample
- Samples appear to be in an acceptable condition (i.e., cassettes are not cracked; sample containers are not leaking, etc.).
- No information is provided on the sample or sample container that would disclose the origin of the sample to the facility

The FSC will immediately contact the sampler if any acceptance issues are encountered. Once accepted, the FSC will prepare a COC using EPA-specified data management tools (e.g., Data Entry Tool, Scribe). An investigation-specific Analytical Summary Sheet (available in the SAP or Libby Field eRoom) will be attached to the COC. The FSC will group or batch the appropriate number of individual samples on a COC to facilitate data reporting, or as otherwise requested by the LC.

The following general batching guidelines will be used for commonly sampled Libby Site media:

- 10 or fewer non-clearance air samples on one COC
- one set of five clearance air samples and two corresponding field blanks on one COC
- 20 or fewer soil or soil-like (e.g., duff, wood chip) samples on one COC
- 10 or fewer dust samples on one COC

Following coordination with the LC, the FSC will hand deliver or ship samples (following project-specific SOP EPA-LIBBY-2012-07, *Packaging and Shipping Environmental Samples*) to the designated facility. All samples will be maintained in a secure location by the FSC until they are relinquished to another party.

5.3 Post-operation

Sample documentation (logbooks, FSDSs, field copy of the COC, etc.) will be maintained in accordance with Libby Site data management requirements and any special requirements stated in the governing document referencing this SOP (e.g., posting to an eRoom).

6.0 Restrictions/Limitations

For EPA Contract Laboratory Program sampling events, combined chain-of-custody/traffic report forms generated with Scribe or other EPA-specific records may be used. Refer to EPA regional guidelines for completing these forms. Scribe software may be used to customize sample labels and custody records when directed by the client.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

7.1 Training

Every effort will be made to ensure proper sample custody from the point of collection to final disposition. Sample custody will be maintained to the extent possible through proper training, use of designated field staff, and provision of TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require staff re-training.

7.2 Field Checks

Field checks for adherence to this SOP may be performed on a daily basis by the TL for the first week of each field activity. These checks can be extended to once per month as field activities continue. Any non-compliance issues will be discussed with field personnel and corrected. If field activities continue beyond six months, the frequency of assessing sample custody procedures will be established by the field Quality Assurance Manager.

8.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 1-2, Sample Custody, January 2012.

Libby Asbestos Superfund Site
Standard Operating Procedure
Packaging and Shipping Environmental Samples

Prepared by: _____ Date: 4/12/12
CDM Smith

Approved by: _____ Date: 4/12/12
EPA Region 8

Revision No.	Date	Reason for Revision
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1.0 Objective

The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for the packaging and shipping of environmental samples collected by the U.S. Environmental Protection Agency or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Sections 2.0 through 7.0 of this SOP outline requirements for the packaging and shipping of regulated environmental samples under the U.S. Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations (for shipment by air) and applies only to domestic shipments.

This SOP does not cover the requirements for packaging and shipment of equipment or bulk chemicals that are regulated under the DOT, IATA, and ICAO, nor does it address shipment of hazardous materials. Hazardous material will not be shipped unless personnel have received training that meets the requirements of the governing agency and the DOT.

Additions or modifications to this SOP may be detailed in governing documents referencing this SOP.

2.0 Background

2.1 Definitions

Bottle ware – Plastic or glass bottles or jars used to contain sampled material. Their purpose is to keep sampled material from mixing with the ambient environment.

Chain-of-custody record (COC) – Used to document the custody, control, transfer, analysis, and disposition of samples.

Custody seal – An adhesive-backed seal that is applied to an individual sample or sample container to demonstrate that sample integrity has not been compromised during sample transfer.

Environmental sample – An aliquot of air, water, plant material, sediment, or soil that represents potential contaminant levels at a site. This procedure applies only to environmental samples that

contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Facility – A sample processing facility, analytical laboratory, or long-term storage area that serves as the receiver for Libby Site samples.

Excepted quantity – Excepted quantities are limits to the mass or volume of a hazardous material in the sample containers below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Limited quantity – Limited quantity is the maximum amount of a hazardous material below which there are specific labeling or packaging exceptions.

Performance testing – Performance testing is the required testing of outer packaging. These tests include drop and stacking tests.

Qualified Shipper – A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

Site – All buildings (if applicable) and land within the boundaries of the EPA's designated geounits, which may represent individual properties within the Libby Site, a collection of properties, or a larger geographical area.

2.2 Discussion

Proper packaging and shipping is necessary to ensure the integrity of environmental samples during transport. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both the governing agency and the individual employee at risk of serious fines.

3.0 Responsibilities

Successful execution of this SOP requires a clear definition of assigned roles and responsibilities. All staff responsible for packaging or shipping Libby Site environmental samples will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this SOP.

Team Leader (TL) – Responsible for overseeing sample packaging and shipping processes as described in this SOP.

Packager/Shipper – Party (typically the Field Sample Coordinator or Sampler) responsible for properly packaging and shipping samples to the designated project facility.

Qualified Shipper – Responsible for ensuring that samples undergoing shipment contain no other contaminant that meets the definition of "hazardous material" as defined by DOT, and for determining the amount of preservative in each sample so that accurate determination of quantities can be made.

4.0 Equipment

4.1 Environmental Samples without Preservatives

The following equipment will be used when packaging and shipping Libby Site samples:

- Shipping containers (e.g., insulated cooler for limited quantities, a sturdy box for air samples)
- Bubble wrap or other space filler
- Heavy-duty plastic garbage bags
- Plastic zip-top bags
- Custody seals
- Clear packaging tape
- Completed chain-of-custody record
- Duct tape
- Completed shipping label
- Completed return address label (for return of coolers)

Vermiculite, shredded paper, expanded polystyrene, or other absorbent material will not be used for packaging or shipping Libby Site samples. Plastic bubble wrap and ice (as required) is acceptable packing material.

4.2 Environmental Samples with Preservatives

In addition to the equipment listed in Section 4.1, the following additional equipment is required when packaging samples containing preservatives:

- Sample containers
- Insulated coolers
- ice packs/bags or “blue ice”
- Sample labels
- Nitrile gloves

5.0 Procedures

5.1.1 Preparation

Considerations that must be made prior to shipping samples include selecting the appropriate shipping option (e.g., overnight delivery) so that analytical holding times for the samples are not exceeded; packaging samples in time to meet courier or shipping service pick-up times; and making arrangements with the project facility regarding Saturday receipt of samples.

5.2 Operation

5.2.1 Solid Media Samples without Preservatives

The following processes will be employed by the Packager/Shipper for non-preserved, solid media samples (soil, duff, bark, bulk material), and samples collected on cassettes (air, dust). Section 5.2.2 provides procedures for packaging and shipping aqueous samples (groundwater, surface water), or samples with aqueous content (sediment, sludge). Due to the potential for cross contamination, samples collected on cassettes must not be shipped in the same container as solid media samples. Refer to the guidance document referencing this SOP for temperature control requirements (ice).

1. Verify the samples undergoing shipment meet the definition of an “environmental sample” and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the Health and Safety Manager shall be observed.
2. Select a sturdy shipping container. Ensure that coolers are in good repair. Air and dust samples must be shipped in separate containers from solid media samples.
3. Place samples into the shipping container. During placement, ensure custody seals are securely in place and verify the contents of the shipping cooler against the COC. The COC shall reflect only those samples within the shipping container.
4. Fill all remaining space with bubble wrap or other appropriate space filler, to prevent the sample(s) from being jostled.
5. After the COC has been signed and dated (time included), retain the field copy of the COC. If using a cooler, place the following items into a zip-top plastic bag for inclusion in the cooler: the top two copies of the COC, an analytical parameters table (if applicable), a copy of the investigation-specific analytical requirements summary sheet (applicable to any asbestos analysis), a completed return shipping label for return of the cooler, and any additional contact, results distribution, or billing information. Tape the sealed zip-top bag to the inside of the cooler lid and securely close. If using a box, include all aforementioned documentation inside the box along with the samples.
6. Attach a completed custody seal across the opening of the shipping container on opposite sides. If using a cooler, the cooler lid shall be secured with tape by wrapping each end of the cooler a minimum of two times. The tape shall be affixed to the cooler so that only half of the custody seal is covered, preventing the cooler from being opened without breaking the seal.
7. Secure the completed shipping form to the shipping container. Schedule the container for pickup or drop off at shipper.
8. Once the container is shipped, notify the laboratory of the shipment number and anticipated arrival date/time.

5.2.2 Aqueous or Aqueous-content Samples without Preservatives

This process below will be employed by the Packager/Shipper for non-preserved, aqueous (or aqueous content) samples collected in bottle ware (water, sediment, sludge). Refer to the guidance document referencing this SOP for temperature control requirements (ice).

1. Verify the samples undergoing shipment meet the definition of an “environmental sample” and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the Health and Safety Manager shall be observed.
2. Be sure the caps on all bottles are tightened to prevent leaking. Ensure custody seals are securely in place.
3. For glass containers, wrap each container in bubble wrap and secure with waterproof tape to prevent breakage.
4. Place each plastic or bubble-wrapped glass container into a zip-top bag. Smaller glass containers, such as 40-milliliter vials, may be wrapped together for the same sample.
5. Remove as much trapped air when sealing the bag.

6. Select a sturdy cooler in good repair. To control contents: duct tape closed any interior drain plugs from the inside; duct tape closed any exterior drain plugs from the outside; and line the cooler with two large heavy-duty plastic garbage bags.
7. Place the samples into the cooler with sufficient space to allow for the addition of packing material between the samples. It is preferable to place glass sample bottles and jars into the cooler vertically (glass containers are less likely to break when packed vertically rather than horizontally). During placement, verify the contents of the shipping cooler against the COC. The COC shall reflect only those samples within the cooler.
8. Fill all remaining space with bubble wrap or other appropriate space filler to prevent the sample(s) from being jostled.
9. After the COC has been signed and dated (time included), retain the field copy of the COC. Place the following items into a zip-top plastic bag for inclusion in the cooler: the top two copies of the COC, an analytical parameters table (if applicable), a copy of the Analytical Summary Sheet as provided in the governing document referencing this SOP (only applicable to asbestos analysis), a completed return shipping label for return of the cooler, and any additional contact, results distribution, or billing information. Tape the sealed zip-top bag to the inside of the cooler lid and securely close.
10. Fill all remaining space between the samples with packing material. Remove excess air from garbage bags and seal each bag by securely taping the opening closed and then applying a custody seal on the outermost bag.
11. Attach a completed custody seal across the opening of the cooler on opposite sides. The cooler lid shall be secured with tape by wrapping each end of the cooler a minimum of two times. The tape shall be affixed to the cooler so that only half of the custody seal is covered, preventing the cooler from being opened without breaking the seal.
12. Secure the completed shipping form to the shipping container. Schedule the container for pickup or drop off at shipper.
13. Once the container is shipped, notify the laboratory of the shipment number and anticipated arrival date/time.

5.2.3 Samples Requiring Temperature Controls

If temperature controls (i.e., ice) are required (refer to the guidance document referencing this SOP), in addition to the procedures listed in Section 5.2.1 (for solid media samples) or Section 5.2.2 (for aqueous samples), the Packager/Shipper will:

1. Duct tape closed any drain plugs (inside and outside) and line the cooler with two large heavy-duty plastic garbage bags. (This step will already have been performed for aqueous/aqueous-content samples.)
2. Place ice in one-gallon plastic zip-top bags and properly seal the bags.
3. Place bags of ice on top of and between the samples to ensure adequate temperature controls during transport.
4. Ensure a temperature blank is secured inside the cooler.

5.2.4 All Samples with Preservatives

Prior to shipping samples with preservatives, the Qualified Shipper will determine the amount of preservative in each sample. Excepted quantities of preservatives are provided in the following table:

Excepted Quantities of Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
5 drops = 1 ml		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
NaOH	30%	>12	0.08%	--	0.25	0.5	1	2
HCl	2N	<1.96	0.04%	0.2	0.5	1	--	--
HNO_3	6N	<1.62	0.15%	--	2	4	5	8
H_2SO_4	37N	<1.15	0.35%	0.1	0.25	0.5	1	2

Conc. = concentration
ml = milliliters
% = percent
L = liter
NaOH = sodium hydroxide
HCl = hydrochloric acid
HNO_3 = nitric acid
H_2SO_4 = sulfuric acid

In addition to the steps outlined in the appropriate section above for the specific media sampled, these additional steps are to be followed when packaging limited-quantity sample shipments:

1. Nitrile gloves are to be worn by anyone handling the sampling containers.
2. All sample containers will be labeled with the sample number and what preservative is being used. Protect the labels with waterproof tape. At a minimum the sample label must contain:

    - Sample number
    - Project or Case number
    - Date and time of sample collection
    - Preservative
    - Analysis

The FSDS will be used to collect all other sample information.

3. The Packager/Shipper will ensure a trip blank(s) is secured inside the cooler(s).
4. The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.

5.3 Post-operation

Shipping documentation will be maintained by the Packager/Shipper to confirm that shipments have been delivered and accepted by the receiver.

6.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this SOP.

6.1 Training

Every effort will be made to ensure proper sample custody from the point of collection to final disposition. Sample custody will be maintained to the extent possible through proper training, using designated field staff, and providing TL oversight. Any deficiencies or inconsistencies in implementing this SOP noted by the TL will require staff re-training.

6.2 Field Checks

Field checks for adherence to this SOP may be performed on a daily basis by the TL (or their designate) for the first week of each investigation. These checks can be extended to once per month as investigation activities continue, and any errors noticed during the checks will be discussed with field personnel and corrected. If investigation activities continue beyond six months, the frequency of assessing sample packaging and shipping procedures will be established by the field Quality Assurance Manager or their designate.

7.0 References

Adapted from CDM Smith Technical Standard Operating Procedure 2-1, Packaging and Shipping Environmental Samples, January 2012.

Libby Asbestos Superfund Site
Site-specific Procedure
Completion of Field Sample Data Sheets

Prepared by: Diane M Rode Date: 4/18/12
CDM Smith

Reviewed by: Thomas Cook Date: 4/18/12
CDM Smith Technical Reviewer

Reviewed by: Jerry Cornell Date: 4/18/12
CDM Smith Quality Assurance Reviewer

Revision No.	Date	Reason for Revision
0	5/8/02	--
1	5/16/03	Annual update to align guidance with current versions of FSDSs
2	--	Not finalized/approved
3	4/12/06	Annual update to align guidance with current versions of FSDSs
4	4/13/09	Annual update to align guidance with current versions of FSDSs
5	5/26/09	Minor administrative changes to address FSDS changes
6	4/18/12	Annual update to align guidance with current versions of FSDSs

1.0 Objective

The objective of this site-specific procedure is to establish baseline requirements, procedures, and responsibilities for the completion of field sample data sheets (FSDSs) by the U.S. Environmental Protection Agency (EPA) or its contractors in support of the Libby Asbestos Superfund Site (Libby Site). Additions or modifications to this procedure may be detailed in governing documents referencing this SOP.

2.0 Definitions

Data Entry Tool (DET) – A local MS Access tool used to enter information from the FSDS and used to temporarily store information until it is published to Scribe.

Field sample data sheet (FSDS) – The hard copy form on which sample and location information is recorded.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the most recent version of the OU boundary map.

Response Manager – An EPA data management system used to manage property information.

Scribe – An EPA data management system used manage location, sample, and analytical data.

3.0 Responsibilities

Team Leader (TL) – Responsible for ensuring that FSDSs are completed in accordance with this procedure and any additional FSDS requirements stated in the governing document referencing this procedure.

Sampler – Responsible for completing FSDSs in accordance with this procedure and any additional FSDS requirements stated in the governing document referencing this procedure.

Field Sample Coordinator (FSC) – Staff member to whom samples and FSDSs are relinquished; responsible for preparing chain-of-custody forms (COCs) and submitting samples to the appropriate project facility.

Office Administrator – Responsible for preparing sample number and location identification (ID) logs and labels, and preparing unique and sequentially numbered FSDSs for completion in the field.

4.0 Operation

4.1 Recording Information for All Sampling Media

This section provides background information, as well as descriptions and instructions for completing FSDS data items common to all sampled media. Data items specific to certain media are discussed in Section 4.2.

Some FSDS data items are required to be completed to be in compliance with EPA data reporting requirements or the governing document referencing this procedure, or to track other critical field information. These data items will be referred to as "required" throughout this procedure. Required data items are indicated on FSDSs with an asterisk (*). A required data item must be populated with an appropriate valid value. Note that "NA" (not applicable) may be a valid value.

Other data items may be required conditionally. These will be referred to as "conditional" throughout this procedure and these fields will not be asterisked on the FSDS. Conditional data items and any corresponding valid values may be specified in EPA data reporting requirements or the governing document referencing this procedure.

Data items that are not required or conditional may be left blank. Information recorded on the FSDS is entered into the DET.

Field team members are not required to line out any labels, initial, or date them, unless they are making a revision. To revise a data item on an FSDS, line through the incorrect data (single line), record the correct data in close proximity to the erroneous data, and date and initial the change.

Sheet No.: A pre-assigned unique, sequential sheet number assigned by an Office Administrator, in the format: $$-###### or $-######, where $ refers to the media being sampled and ###### refers to the sequential number.

Event ID: An identifier for a specific data collection effort, most commonly a combination of the event-specific sample number prefix and the approved date of the document governing the event. These Event IDs use the format: $$-######, where $$ refers to the sample number prefix and ###### refers to the governing document date in MMDDYY format.

Address: The concatenated address (as it appears in Response Manager) of the property being investigated and/or sampled.

Date: The date of sample collection in the form MM/DD/YY. For air samples collected over more than one day using the same cassette, the end date (i.e., date the sample period concludes) will be recorded.

Property ID: For non-OU7 properties, a unique identifier assigned to each property in the format: AD-######, where ###### is a unique number. OU7 Property IDs use the format: AD-2#####. Property IDs should be verified using Response Manager before being transcribed to the FSDS. Property IDs may be used as Location IDs in appropriate circumstances.

Field Logbook No.: The number of the logbook being used to record information specific to the samples on the FSDS.

Page No.: The page number(s) in the logbook being used to record information specific to the samples on the FSDS.

Sampler(s): The first initial and full last name of all members of the field team. For removal-related samples, the Third Party Quality Assurance oversight (TQA) staff member name should also be listed. For data entry, the FSC will select only one of the field team members listed. The company affiliation of the field team member(s) or TQA need only be listed after their name if they work for a company other than "CDM Smith".

Location ID: A unique number assigned to each location representing the investigated and/or sampled area specific to the information on the FSDS. Previously assigned Location IDs should be verified using Scribe before being transcribed to the FSDS, whenever possible. Contact a member of the onsite data management team for assistance with verification.

Location IDs in the format BD-###### will be assigned to (or used for, in the case of previously assigned Building Location IDs) habitable, fully enclosed primary or secondary buildings, including buildings that may have broken windows and/or missing doors. A Building Location ID will be used for samples collected within the habitable, fully enclosed structure, including soil samples from soil floors and samples within understructures (e.g., basement, cellar, crawlspace).

Location IDs in the format XX-###### will be assigned to outdoor investigation areas, including soil areas beneath carports, decks, and porches, or within open structures (e.g., 3-sided structures, carports, and lean-tos). XX-###### Location IDs will not be used during removal soil confirmation sampling.

Location IDs in the format SP-###### will be assigned to outdoor excavated soil areas (including areas with open structures) during removal soil confirmation sampling.

For personal and stationary air samples, a previously assigned Property ID or Building Location ID will be used in most cases. If a new Location ID is assigned, the Location portion of the Soil-like and Location FSDS must be completed in addition to the Air FSDS.

For lot blanks, AD-OU4NA is used for the Property ID and Location ID.

For field blanks, generally, the Property ID where field samples are being collected is used for outdoor sampling, while the Building Location ID is used if sampling occurs indoors. For air and dust field blanks specifically, the Location ID should be used that corresponds to the air space where the field blank is exposed (i.e., Property ID for field blanks exposed in outdoor spaces; Building Location ID for field blanks exposed in indoor living spaces).

Sample ID: Unique number assigned to each sample in the format $-##### or $$-#####, where $ or $$ is a one- or two-digit set of characters indicating the governing document referencing this procedure, and ##### is a 5-digit sequential number.

For Field Team Completion, Completed by: Initials of the field team member, verifying that required data items on the FSDS have been completed correctly.

For Field Team Completion, Quality Checked (QC) by: Initials of the second field team member (independent of the member completing the FSDS) or other trained reviewer, verifying that required data items on the FSDS have been completed correctly.

For Data Entry, Entered by: Initials of the FSC or data entry staff performing data entry of FSDS information into the DET.

For Data Entry, QC by: Initials of the FSC or other trained reviewer verifying FSDS data entered into DET is complete and accurate.

4.2 Recording Media-specific Information

The following sections provide instructions for recording media-specific information on FSDSs.

4.2.1 Soil-Like Material

Is this a new Location: Select the appropriate Location ID response. Use "Yes" when assigning a new Location ID; use "No" when a Location ID has previously been assigned, and use "Revised" when revising previously collected location data.

Location Type: Record the location type of the area being investigated and/or sampled. For removal confirmation soil samples, use "EA" for excavation area. For perimeter or clearance air samples, or water samples, use "NA". For General Property Investigation (GPI) locations/samples, select from the following values (abbreviations may be used):

SP – sampling point
SUA – specific-use area
RUA – road-use area
SB – secondary building
EA – excavation area
CUA – common-use area
NUA – non-use area
SS – secondary structure
NA – not applicable
LUA – limited-use area
PB – primary building

Location Description: Record the description of the area being investigated and/or sampled. Select from the following values (do not abbreviate):

alley	flowerbed	road (paved)
animal pen	former house foundation	road (unpaved)
apartment	garage	root zone
barn	garden	shed
borrow source	greenhouse	shop
building	house	shrub bed
burn pile	lean-to	stockpile
carport	NA	underneath porches/decks
decorative gravel/rock	outhouse	underneath secondary structure
driveway (paved)	park	undeveloped Area
driveway (unpaved)	parking lot (paved)	walkway (paved)
field (maintained)	parking lot (unpaved)	walkway (unpaved)
field (unmaintained)	property	wooded area
fire pit	pumphouse	yard
flower pots	right of way - only	

Location Area: Record the square footage of the area to which the FSDS pertains. This data item may be left blank if not specified in the governing document referencing this procedure.

Location Comment: For GPIs, describe the restoration type applicable to a location. This data item may be left blank if not required by the governing document referencing this procedure.

building	pea gravel	topsoil
chipped rock	potting soil	topsoil w/liner
common fill	sand	washed rock
grass	structural fill	wood chips
landscape rock	tall grass	wooded area

Location Comment 2: Record the detailed description of the location that may not be reflected in the Location Comment. This data item may be left blank if not specified in the governing document referencing this procedure.

Visible Vermiculite: Record the total number of visual inspection points of no (N), low (L), intermediate (M), or high (H) levels of vermiculite observed during the semi-quantitative visual inspection for vermiculite. For visible vermiculite observations corresponding to a sample, the sum of these fields must equal the number of sample aliquots (e.g., 30). If no sample is collected, the sum relates to the estimated location area, as specified in the governing document referencing this procedure. Values for visual inspection point observations (N, L, M, or H) must be provided; use zero to indicate no observations were required/made.

Top Depth: Record the top depth of the sample and/or visual inspection observation, recorded in inches, in relation to ground surface. For samples collected below ground surface, record a positive,

whole number. For samples collected above ground surface (e.g., vegetative samples), record a negative, whole number.

Bottom Depth: Record the bottom depth of the sample and/or visual inspection observation, recorded in inches, in relation to ground surface. For samples collected below ground surface, record a positive, whole number. For samples collected above ground surface (e.g., vegetative samples), record a negative, whole number.

Visible Vermiculite Sub-location: For exterior samples use "Property (exterior)". For GPI interior locations, select from the list below. This data item may be left blank if not specified in the governing document referencing this procedure.

property (exterior)	crawlspace	soil floor
basement	cellar	

Visible Vermiculite Comments: Record any comments pertaining to the visual inspection observation. This data item may be left blank if not specified in the governing document referencing this procedure.

Sample Collected: Circle "Yes" or "No". If no sample is collected, "Z" out and initial the data items from "Sample ID" to "Sample Field Comments".

Sample ID: Record the unique sample number assigned to each sample, as designated by the governing document referencing this procedure.

Sample Time: Record the time (in military units) the sample was collected.

ABS Y/N: Record whether the sample was collected as part of an activity-based sampling program.

Sample Venue: Record whether the sample was collected indoors or outdoors. Use "NA" for field blanks.

Sample PrePostClear: For removal confirmation soil samples, circle the appropriate clearance sequence. For all other samples, circle "NA" unless otherwise specified in the governing document referencing this procedure.

Sample Type: Circle "FS" for a field sample, "FD" for a field duplicate, or write in an alternative sample type if specified in the governing document referencing this procedure.

Sample Parent ID: Record the parent Sample ID for soil field QC samples (e.g., duplicates, replicates). Refer to the governing document referencing this procedure for field sample QC requirements.

Composite Y/N: Indicate if the sample collected is a composite. Circle "N" if the sample is a grab sample.

Sample/Inspection Aliquots: For 30-point composite samples, circle "30", or indicate the number of aliquots inspected and/or collected in the space provided. If a grab sample was collected, circle "0".

Sample Location Description: For exterior removal confirmation soil samples, provide the sampling areas designation(s) corresponding to the TQA draft redline sketch. For interior removal confirmation soil samples, record the building description and the sampling areas designation(s) corresponding to the TQA draft redline sketch where the sample was collected (e.g., greenhouse; Area 1; Area 12, pumphouse; Area 3, crawlspace). For GPI and other sampling programs, provide any detailed location information that may not be reflected in the general Location Description, such as restoration type (e.g., structural fill) or specific area of the building that was sampled (e.g., middle of barn, SW corner of crawlspace).

Sample Field Comments: Record any additional information that may be useful to data users. Refer to the governing document referencing this procedure for any specific requirements.

4.2.2 Stationary Air

As mentioned in Section 4.1, a previously assigned Property ID or Building Location ID will be used on the FSDS for stationary air samples in most cases. Property IDs are used for stationary air samples collected outside buildings, while Building Location IDs are used for samples collected inside buildings. If a new Location ID is assigned, the Location portion of the Soil-like and Location FSDS must be completed in addition to the Air FSDS.

Sample ID: A unique sample number assigned to each sample, as designated by the governing document referencing this procedure.

ABS N/Y: Record whether the sample was collected as part of an activity-based sampling program.

Sample Venue: Record whether the sample was collected indoors, outdoors, both, or NA. The Sample Venue for field blanks should be recorded as "NA". For samples collected inside a vehicle with the windows closed, circle "Indoor". For samples collected inside a vehicle with the windows open, circle "Both".

Sample PrePostClear: For removal clearance air samples, circle the appropriate clearance sequence. For all other samples, including field blanks, circle "NA" unless otherwise specified in the governing document referencing this procedure.

Sample Type: Circle "FS" for a field sample, "FD" for a field duplicate, "LB" for lot blank, "DB" for drying blank, or write in an alternative sample type as specified in the governing document referencing this procedure.

Sample Parent ID: Applicable to the high volume sample, when co-located high- and low-volume samples are collected. For the high-volume sample, record the low-volume Sample ID as the Sample Parent ID. For the low-volume sample, the Sample Parent ID is left blank.

Sample Location Description: Provide a detailed description of the indoor or outdoor sample location. Record "Blank" for field blanks. Refer to the governing document referencing this procedure for any additional requirements.

Sample Air Type: Circle the appropriate stationary air type (Ambient or Perimeter). The Sample Air Type for blanks should be recorded as "NA".**Sample Air Volume Type:** When co-located high- and low-volume samples are collected, record "LV" for low-volume or "HV" for high-volume samples. Record "NA" for all other samples.

Flow Meter Type: Circle the applicable flow meter used. Circle "NA" for all types of blank samples.

Cassette Lot Number: Record the cassette lot number of the sample cassettes being used.

Flow Meter ID Number: Record the identification number of the flow meter used. If more than one flow meter is used, use Sample Field Comments to record the additional Flow Meter ID(s).

Pump ID Number: Record the ID of the pump used. If more than one pump is used, use Sample Field Comments to record the additional pump ID(s), and provide the reason for use of multiple pumps. For all types of blank samples, "Z" out the data items from "Pump ID" to "Sample Air Stop Flow".

Sample Air Start Date: Record the start date in the format MM/DD/YY. Note that multiple start and stop dates/times, as well as start and stop flow rates, may need to be recorded for samples collected over multiple days using the same cassette. Refer to the governing document referencing this procedure for additional requirements.

Start Time: Record the starting time (in military units) of each air sample aliquot.

Start Flow: Record the starting pump flow rate, in liters per minute (L/min) for the air sample collected.

Stop Date: Record the stop date in the format MM/DD/YY.

Stop Time: Record the stopping time (in military units) of each air sample aliquot.

Stop Flow: Record the stopping pump flow rate (in L/min) for the air sample collected. If a flow rate is recorded while the pump is running, the stop time and next recorded start time will be the same.

Pump Fault: Circle "Y" or "N" to indicate a pump fault. For all types of blank samples, circle "NA". Use Sample Field Comments to note if a pump faulted during air sample collection, as determined by an unacceptable flow rate deviation (refer to the governing document referencing this procedure for flow rate requirements), or due to a mechanical fault (pump shut-off).

Sample Total Time (min): Sample Total Time is the total sample collection period in minutes (min). TLs will provide direction on calculating sample times. Generally, removal-related air sample total times will be calculated by the FSC, while other programs (e.g., ABS) will call for samplers to calculate total times.

Sample Quantity (L): The sample quantity represents the total volume in liters (L) of the sample collected. TLs will provide direction on calculating sample quantities. Generally, removal-related air sample quantities will be calculated by the FSC, while other programs (e.g., ABS) will call for samplers to calculate sample quantities.

Sample Field Comments: Record any additional information that may be useful to data users. Refer to the governing document referencing this procedure for any specific requirements.

Filter Diameter: For all standard Libby Site air sampling, sample cassettes with a 25-millimeter filter diameter will be used. This data item is pre-printed on the Air FSDS.

Pore Size: For standard Libby Site air sampling, sample cassettes with a 0.8-micron filter pore size will be used. This data item is pre-printed on the Air FSDS.

4.2.3 Personal Air

Complete Personal Air FSDSs as for Stationary Air, with the following adjustments:

Sample PrePostClear: For all samples and blanks circle "NA" unless otherwise specified by the governing document referencing this procedure.

Sample Air Type: Circle one of the following personal air types:

- TWA – Time-weighted average sample, collected over an 8-hour period (may be composited with other personal air samples to represent an average work day)
- EXC – Excursion sample, collected over a 30-minute period (time may be approximate)
- ABS – Sample collected during activity-based sampling (<u>not</u> health and safety related)
- NA – Use for all types of blank samples, or as specified in the governing document referencing this procedure

Personnel ID: Record the 4-digit company-assigned ID of the worker being monitored.

Name: Record the first and last name of the worker being monitored.

Personnel Task: For health and safety-related samples, select from the list below. For samples collected as part of ABS, refer to the governing document referencing this procedure for requirements.

bulk removal	investigation (Level D)	removal oversight (Level D)
demolition	laborer	support personnel
detailing attic	operator	truck driver (Level C)
excavator operator	other	truck driver (Level D)
investigation (Level C)	removal oversight (Level C)	wet wipe/HEPA vac living space

For samples collected at Rainy Creek Rd or Lincoln County Landfill, select the most appropriate value from the list above, and then provide additional information in Sample Field Comments from the list below:

upper dozer	laborer - PAPR
water truck driver – PAPR	equipment operator - PAPR
truck driver – PAPR	truck driver – Level C and Level D

Libby Asbestos Superfund Site
Site-specific Procedure
Confirmation Soil Sample Collection

Prepared by: Matt Ecl Date: 2/11/13
CDM Smith

Reviewed by: Connie Pucarelli Date: 2/11/13
CDM Smith Technical Reviewer

Reviewed by: Robert R. Alexander Date: 2/11/13
CDM Smith Quality Assurance Reviewer

Revision No.	Date	Reason for Revision
0	4/9/08	--
1	6/28/11	• Administrative updates
2	5/1/12	• Administrative updates • Change in composited soil sample size from 2,000 – 2,500 grams to 750 – 1,000 grams
3	2/11/13	• Clarify the definition of visible vermiculite

1.0 Objective

The objective of this site-specific procedure is to establish baseline requirements, procedures, and responsibilities for the collection of 30-point composite confirmation soil samples by the U.S. Environmental Protection Agency (EPA) or its contractors related to response actions conducted at the Libby Asbestos Superfund Site (Libby Site). This procedure describes the equipment and operations to be used for sampling surface soils for the analysis of Libby amphibole asbestos. Additions or modifications to this procedure may be detailed in governing documents referencing this procedure.

2.0 Background

2.1 Definitions

Composite sampling – A sampling approach in which multiple sample points are compiled together and submitted for analysis as a single sample.

Confirmation soil sample – For the purpose of this procedure, a confirmation soil sample is a sample intended to provide data of sufficient quality to meet the data quality objectives defined in the governing document referencing this procedure. More specifically, confirmation soil samples are intended to provide confirmation analytical data post-visual inspection.

Field sample data sheet (FSDS) – The controlled (i.e., pre-numbered and tracked) hard copy form on which sample and location information and vermiculite observations is recorded.

Libby Asbestos Superfund Site (Libby Site) – All buildings and land within the boundaries of the EPA's designated operable units (OUs), as illustrated on the current version of the OU boundary map.

Sample identification (ID) label – Pre-printed sticker used to label sample containers and on field documentation (e.g., FSDSs) to minimize sequencing or transcription errors.

Site-specific removal work plan – The document that spells out the detailed property-specific removal activities to be performed. Site-specific removal work plans will clearly designate excavation areas where this procedure is expected to be implemented.

Subsample – The portion of a composite sample representing a discreet location within the sampled area.

Visible Vermiculite – Exfoliated and/or unexfoliated vermiculite, amphibole asbestiform minerals, and mine tailings present in soils as part of response actions – herein collectively referred to as visible vermiculite (VV).

2.2 Discussion

Composite sampling involves soil collection from multiple subsample locations within a specified area. Confirmation soil sampling will consist of collecting one 30-point composite sample from a defined excavated area or areas as detailed draft redline drawing. The 30 subsamples will be of approximately equal volume for a final sample volume between 750 and 1,000 grams (approximately one quarter of a gallon-sized zip-top plastic bag).

As each subsample is collected, the soil in the immediate area and within a radius of 2 feet from the center of each subsample (i.e., the field of view of the subsample location), will be visually inspected for vermiculite. The location and semi-quantitative estimates of VV will be recorded on a copy of draft redline drawing as described in Section 5 below.

3.0 Responsibilities

Successful execution of this procedure requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for collecting soil samples using this procedure will understand and implement the requirements contained herein, as well as any additional requirements stated in governing documents referencing this procedure.

Team Leader (TL) – The TL is responsible for overseeing the sample collection process outlined in this procedure, and for checking and verifying that the work performed satisfies the objectives of the governing document referencing this procedure. The TL will communicate with the field team members regarding specific collection objectives, and will communicate the need for any deviations from this procedure with the appropriate client personnel, and document the deviations using a Libby Field Record of Modification Form, as provided in the governing document referencing this procedure.

Field Team Members - Field team members performing the sampling described in this procedure are responsible for adhering to the tasks specified herein. The field team members should have

limited discretion with regard to collection procedures but should exercise judgment regarding the exact location of sample points, within the boundaries outlined by the TL.

4.0 Equipment

The following equipment will be used during implementation of this procedure:

- Measuring tape or wheel – Used to estimate the square footage of each land use area.
- Trowel or push probe
- Gallon-sized plastic zip-top bags – Used as sample containers (two bags per sample).
- Personal protective equipment (PPE) – For personal protection and to prevent cross-contamination of samples (e.g., disposable, powderless plastic or latex gloves).
- Field sprayers – Used to suppress dust during sample collection and to decontaminate nondisposable sampling equipment between samples.
- De-mineralized water – Used in field sprayers to suppress dust and to clean and decontaminate sampling equipment.
- Plastic bristle brush – Used to clean and decontaminate sampling equipment.
- Alconox – Used to clean and decontaminate sampling equipment weekly.
- Paper towels – Used to dry decontaminated sampling equipment.
- 6-mil poly bag – Used to store and dispose of investigation-derived waste (IDW); used to store decontaminated and dried equipment.
- Trash bag – Used to store and dispose of general trash.
- Indelible ink pen (blue or black ink only) – Used to complete field documentation.
- Indelible marker – Used to record sample IDs on sample bags.
- Field logbook – Used to record progress of sampling effort and record any problems and field observations.
- Blank FSDSs
- Sample ID labels
- Cooler or other rigid container – Used to store samples while in the field.
- Custody seals – Self-adhesive seals applied to an individual sample or sample container to demonstrate that sample integrity has not been compromised during sample transfer.

5.0 Procedures

5.1 Preparation

Proper planning and coordination with the sample coordination team and removal contractor is essential to ensure confirmation samples are collected, processed, and analyzed in a timely manner to avoid delaying cleanup progress and any residential relocation. The reader is referred to the site-

specific removal work plan for details regarding horizontal and vertical excavation limits, minimum or maximum square footage restrictions for confirmation soil sampling, and possible deviations to this procedure.

Confirmation samples will be collected once a specified area has undergone soil removal by excavation, digging, or other means and the field team member has deemed the excavated surface is ready for confirmation sampling in accordance with the site-specific removal work plan (i.e., soil has been excavated, at a minimum, to the predetermined depth for that area).

5.2 Sample Collection

Don the appropriate PPE as specified in the governing health and safety plan and/or governing document referencing this procedure. Disposable gloves should be replaced or thoroughly decontaminated between each sample.

Identify excavated areas to be sampled as described in Section 5.1. Although the soil should be moist from engineering controls employed during excavation activities, the field team may use a sprayer to wet each subsample location prior to collection to reduce dust generation during sampling.

Collect horizontal measurements using a measuring tape, wheel, or other acceptable measuring methods to approximate the square footage of the sample area on a copy of the draft redline drawing.

Select 30 subsample locations evenly distributed within the excavated area, equidistant from each other. These 30 subsample locations will comprise the 30-point composite confirmation sample for the excavated area. All composite subsamples will originate from the same area or areas being sampled as one unit.

Using the trowel or push probe, excavate a hole in the soil approximately 2 inches in diameter and 2 inches deep. As each subsample is collected, inspect the soil in the immediate area, or within a radius of approximately 2 feet from the center of each subsample, visually for vermiculite. Assign each subsample a semi-quantitative estimate of VV content using a 4-point scale: none (blank), low (L), intermediate (M), or high (H). Photographs illustrating these quantities are attached to this procedure as Attachment 1. Additionally, jars of vermiculite-containing soils representing these four quantities will be available for training and reference. All staff implementing this procedure will be thoroughly trained in performing semi-quantitative estimates of VV in Libby Site soils.

For subsampling locations where VV is observed, record the estimate (L, M, or H) on a copy of the draft redline drawing. Samples will be collected in teams of two field team members. Each team will consist of one person inside the contamination reduction zone collecting the sample, and one person outside the contamination reduction zone providing outside support, maintaining decontamination equipment, and documenting sample (including VV observations) information. For subsampling locations where VV is observed, the team member inside the contamination reduction zone who observes and semi-quantifies the VV shall communicate the result via hand signals to the outside support person. Holding up an index the finger and thumb on the same hand in the shape of an “L” will signify low amounts of VV observed. Holding up a closed fist will signify

an intermediate amount of VV was observed. Sub-sample locations where VV is not observed will not be recorded on the draft redline drawing.

Once a semi-quantitative estimate of VV is performed for the subsample, place the excavated material directly inside the gallon-sized zip-top plastic bag. Repeat this step for each subsequent subsample until 30 composite subsamples have been collected. It should be noted that a semi-quantitative estimate of high VV in the excavated surface shall necessitate additional excavation (depending upon current EPA cleanup criteria). In these cases, "high" concentrations would not be recorded on the draft redline drawing as all soil containing high concentrations of VV would require additional excavation. Refer to the current version of the Response Action Work Plan for additional guidance.

After placing the material from each subsample inside the bag, thoroughly homogenize the sample to the extent possible. The sample bag should be approximately one-quarter full (approximately 750 to 1,000 grams of material).

Write the Sample ID number on the outside of the bag with indelible marker. Sample ID numbers will be assigned based on the current version of the Response Action Sampling and Analysis Plan. Double-bag the sample and repeat the labeling process for the outer bag. Sign and date a custody seal and affix the seal to the outer bag, ensuring it covers a portion of the bag opening.

Decontaminate reusable equipment between composite samples as prescribed in the governing document referencing this procedure. Decontamination is not required between subsamples.

Repeat steps outlined above until all samples from excavated areas have been collected.

5.3 Handling IDW

IDW will be handled in accordance with the governing document referencing this procedure. Spent wipes, gloves, and PPE must be disposed of or stored properly as IDW in accordance with the governing document referencing this procedure.

6.0 Associated Procedures

6.1 Field Documentation

Field documentation requirements will be specified in the governing document referencing this procedure.

6.2 Sample Custody, Packaging, and Shipping

Sample handling requirements will be specified in the governing document referencing this procedure.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this procedure will be attained through a variety of processes, including, at a minimum, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document referencing this procedure.

7.1 Training

Every effort will be made to ensure consistency in collecting confirmation samples and evaluating the quantity of VV in soil at the Libby Site. Consistency will be achieved to the extent possible through proper training, using designated field staff, and providing TL oversight. Any deficiencies or inconsistencies in implementing this procedure noted by the TL will require re-training of field team members.

7.2 Field Quality Control Samples

Field duplicate samples may be required to be collected as a measure of field quality control (QC). Refer to the governing document referencing this procedure for any field QC sample requirements. If required, field duplicate samples will be collected as samples co-located in the same area as the parent sample. The duplicate will be collected using the same number of subsamples as the parent sample but from different randomly-selected subsample locations. The inspection for VV at each subsample location will follow the same protocol as described above. Duplicate samples will be collected with separate sampling equipment or with the original sampling equipment from the parent sample after it has been properly decontaminated. For tracking purposes, the parent/duplicate sample relationship will be recorded in accordance with sample documentation requirements stated in the governing document, typically on the FSDS.

Libby Asbestos Project
Project-specific Standard Operating Procedure
Stationary Air Sample Collection

SOP No.: CDM-LIBBY-14, Revision 1

1.0 Objective

The objective of this standard operating procedure (SOP) is to establish baseline requirements, procedures, and responsibilities for collecting stationary air samples to support investigations and response actions at residential, commercial, and industrial properties within the Libby Asbestos Superfund Site (site). Modifications to this SOP may be detailed in governing documents referencing this SOP, such as the Response Action Sampling and Analysis Plan (SAP) (CDM 2011).

2.0 Background

2.1 Definitions

Stationary air sample – For the purpose of this SOP, a stationary air sample is a sample intended to provide data of sufficient quality to meet the data quality objectives defined in the governing document.

Libby Asbestos Superfund Site (site) - All buildings and land within the boundaries of each operable unit (OU) of the site as illustrated on the most recent version of the OU boundary map.

2.2 Discussion

Stationary air sampling at the site generally consists of using sampling pumps to draw air over a sample filter for a pre-determined volume in order to measure airborne quantities of Libby amphibole (LA) asbestos.

Stationary air sample data serves many purposes at the site. Stationary air samples may be investigatory in nature, be used to determine compliance with Occupational Safety and Health Administration requirements, or measure attainment of site-specific action levels established by EPA to evaluate remedial actions.

3.0 Responsibilities

Successful execution of this SOP requires a clear hierarchy of assigned roles with different sets of responsibilities associated with each role. All staff responsible for collecting stationary air samples will understand and implement the requirements contained herein, as well as any additional requirements stated in the governing document.

Task Leader (TL) or Field Team Leader (FTL) - The TL (e.g., construction manager) or FTL is responsible for overseeing sample collection processes as described in this SOP. The TL or FTL is also responsible for checking all work performed and verifying that the work satisfies the objectives of the data collection effort as specified in the governing document. The TL or FTL will communicate with the field team members regarding the specific collection objectives and anticipated situations that require deviation from this SOP. It is also the responsibility of the TL or FTL to communicate the need for any deviations from the SOP with the appropriate client personnel, and document the deviation using a Libby Asbestos Project Field Modification Form provided in the governing document.

Field Team Members – Field team members (e.g., third-party quality assurance staff, sampling technicians, etc.) performing response action stationary air sampling are responsible for adhering to the procedures contained in this SOP. The field team members should have limited discretion with regard to collection procedures but should exercise judgment regarding the exact location of sample locations within the specified sampling area. Field team members are also responsible for communicating any consistent problems (e.g., equipment failure during cold weather conditions) with sample collection to the TL or FTL for the purpose of troubleshooting and information sharing with other field team members.

4.0 Required Equipment

- Sampling pump – Low-volume battery powered, such as an SKC Airchek Sampler Model 224-PCXR4, high-volume direct current Gast 1532 rotary vane pump, or equivalent used for collecting air samples.

- Phase contrast microscopy (PCM) sample cassettes - commercially available 25-millimeter (mm), three-piece cassette with a 50mm electronically conductive extension cowl loaded with a 0.8 micron (µ) mixed cellulose ester (MCE) filter.

- Sampling stands – telescoping tripods designed specifically to hold sample cassettes at the desired height will be used to support the sample cassette in order to isolate the sample from the vibrations of the sampling pump.

- Inert tubing – Tygon tubing used in the sampling train to connect the outflow end of the sample cassette to the sampling pump. Tubing has a 3/16" inner diameter and 5/16" outer diameter.

- Rotameter – A rotameter calibrated such that the operator can measure flow rates to ±5% accuracy at the expected sampling flow rate. A rotameter is used as a secondary calibration device.

- Drycal – Drycal will be used to calibrate the rotameter on a quarterly basis. A Drycal is used as a primary calibration device.

- Stationary air field sample data sheets (FSDSs) – Specific data related to the collection of each sample will be recorded on a FSDS. This sheet will contain all relevant

information regarding equipment used, flow rates, and collection times. An example copy of the stationary air FSDS will be included as an appendix in the governing document.

- Permanent marking pen - Used to complete field documentation (e.g., logbooks, FSDSs) and label sample cassettes and containers.
- Sample Identification (ID) Labels (i.e., Sample IDs) – Pre-printed stickers used on field documentation (e.g., FSDSs) and to label sample cassettes and containers.
- Half-quart sized plastic zip-top bags – Used to store individual air sample cassettes to ensure sample integrity and prevent cross contamination.
- Cooler or other rigid container - Used to store bagged samples while in the field. Note that removal activity stationary air samples do not require any preservatives (e.g., ice).
- Custody Seals - For ensuring integrity of samples while in the field and during handling and shipping.
- Small standard screwdriver – Used to adjust the flow rate in low-volume pumps.
- Logbook – Used to record sample information, field observations, and any problems.

5.0 Procedures

Prior to conducting work at any Libby worksite, health and safety procedures, as specified in the governing health and safety plan will be reviewed and the appropriate personal protective equipment (PPE) donned.

5.1 Calibration of Rotameter with an Electronic Calibrator

Rotameters used for pump calibration are calibrated to a primary flow standard on a quarterly basis. The primary flow standard in use at the site is a Dry-Cal (DC)-Lite primary flow meter manufactured by Bios International Corporation. Procedures for rotameter calibration with the DC-Lite flow meter are as follows:

1. Obtain the actual temperature and pressure in Libby, Montana from the local National Oceanic and Atmospheric Administration (NOAA) weather station. Record actual temperature and pressure in the fields provided on the Precision Rotameter Calibration Data Sheet (Attachment 1).

2. Set up the calibration train as shown in EPA SOP #2015 (EPA 1994), Figure 4, with the sampling pump, rotameter, and primary flow meter (Attachment 2).

3. The rotameter will be held perpendicular to the plane of the table no greater than 6° off of vertical.

4. Turn the DC-Lite and sampling pump on.

5. Turn the flow adjust screw or knob on the pump until the desired flow rate is attained.

6. Calibrate rotameter to desired ball reading, as read from the middle of the flow ball, with a sampling pump and sample cassette in-line. The cassette used for calibration must be the same type and from the same lot of sample cassettes that will be used for sampling. Record value in the ball reading column on the rotameter calibration data sheet.

7. Check adjusted flow rate of sample pump to the DC-Lite flow calibrator primary flow standard. Ten repetitive flow measurements will be averaged and that result recorded in the flow rate column for the selected interval.

8. Repeat this process at 10 intervals over the range of the precision rotameter.

9. Input data into rotameter calculation sheet to generate the corrected flow rate.

5.2 Flow Rates and Sample Volume

Response action stationary air samples will be collected using flow rates ranging between 1.0 and 10.0 liters per minute (L/min), with a minimum total sample volume of 1,200 liters. Flow rates will be set at the discretion of the field team member in order to capture, at a minimum, 80 percent (%) of the workday. The sampling pump will provide a non-fluctuating air flow through the filter, and will maintain the initial volume flow rate to within ±10% throughout the sampling period. If at any time the measurement indicates that the flow rate has increased or decreased by more than 10% of the set flow rate, sample collection will cease and the sample will be voided.

In no case will a sample be collected at a flow rate lower than 1.0 L/min, since the linear flow velocity would fall below 4 centimeters per second (cm/sec), which is the minimum velocity specified by the International Organization for Standardization (ISO) method 10312 (ISO 1995) that is used for Libby project air samples.

As samples are initially collected during the sampling event and analyzed, flow rates and sample times may be adjusted to ensure the loading on the sample filter facilitates reaching the required sensitivity goals (i.e., to prevent filter overloading). Filter loading is discussed in more detail in Section 5.4.2 of this SOP.

5.3 Calibration of Sampling Pump with a Rotameter

Each sampling pump will be calibrated before and after each sampling event with a primary or secondary calibration device as described below. This is to ensure that each sampling pump is operating to project requirements as stated in Section 5.2.

The procedures used for sampling pump calibration are as follows:

1. Set up the calibration chain as shown in EPA SOP #2015 (EPA 1994), Figure 5 (Attachment 3) using a rotameter, sampling pump, and a representative sample

cassette. The sample cassette to be used for sampling is installed between the pump and the calibrator.

2. To set up the calibration train, attach one end of tubing to the sample cassette base; attach the other end of the tubing to the inlet plug on the pump. Another piece of tubing is attached from the sample cassette cap to the rotameter.

3. The flow meter should be held within 6 degrees (°) of vertical.

4. Turn the sampling pump on.

5. Turn the flow adjust screw or knob on the manifold regulating air flow to the samples until the middle of the float ball on the rotameter is lined up with the pre-calibrated flow rate value.

Note: A sampling pump, such as a Gast high volume pump, equipped with more than one manifold may be used to collect more than one sample at a time. In the case two samples will be collected from one pump, calibration must be checked after each alteration of the flow regulators. For example: Turn the knob on (manifold A) until the middle of the float ball on the rotameter is at the desired flow rate value. Turn the knob on (Manifold B) until the middle of the float ball on the rotameter is at the desired flow rate value. Verify the calibration of (manifold A), adjust as required. This process must be repeated until both (manifold A) and (manifold B) are at the desired flow rate.

Each rotameter used for field calibration will be transported to and from each sampling location in a sealed zip-top plastic bag.

5.4 Stationary Air Sample Collection

5.4.1 Selection of Stationary Air Sampling Locations

If not specifically discussed in the governing document, the location of each stationary air sample will be determined by field personnel based on site-specific conditions (e.g., placement of the removal contractor's equipment, soil excavation boundaries, etc).

5.4.2 Sample Collection Protocol

Each stationary air sample will be collected according to the following procedures:

1. Place a Sample ID label on the sample cassette indicating a unique sampling ID number. Place the corresponding Sample ID number on the FSDS.

2. Determine proper sample location.

3. Set up the sampling train: attach the air intake hose to the sample cassette base. Follow calibration procedures listed in Section 5.3. The sample cassette will be positioned such that it is held facing downwards at an angle equal to or less than 45° from horizontal. Set the sample cassette to a height of approximately 5 feet

above ground surface. The preferred method is to use a telescoping sample stand or suitable means to place sample at such a desired height. Remove the sample cassette cap and turn the sampling pump on.

4. Record all pertinent information on the FSDS.

5. Check the sampling pump at a minimum of every 4 hours. If the sample filter darkens in appearance or if loose dust is observed inside the cassette, the sample period will be terminated and the remaining steps below followed to complete collection of the sample. The loading observations will be noted on the FSDS in the comment section.

6. At the end of the sampling period, orient the sample cassette to face upwards. Do not remove the sampling cassette from the sampling train. Turn the pump off.

7. Collect the post-sampling flow rate with one of the calibration devices. The same sample cassette will be used to determine the post-sampling flow rate.

8. Record the post-sampling flow rate.

9. Record the stop date and time.

10. Remove the tubing from the sample cassette. Still holding the sample cassette upright, replace the inlet plug on the sample cassette cap and the outlet plug on the sample cassette base. Do not put sample cassettes in shirt or coat pockets as the filter can pick up fibers.

11. Sign and date a custody seal and wrap it around both ends of the sample cassette.

12. Place each sample cassette in a half-quart sized plastic zip-top sample bag. Each bag should be marked with indelible ink indicating the Sample ID number.

5.4.3 Pump Failure Procedures

If a sampling pump faults prior to the total desired run time, the following procedures will be used:

1. Record the time of the observed pump fault in the comments section of the FSDS.

2. If using a SKC low-volume pump, record the total sample time (in minutes) from the pump counter and note accordingly in the comments section of the FSDS sheet, then add total minutes collected to the start time and document the actual stop time in the stop time section of the FSDS.

3. If no minutes appear on the pump counter, void the sample and recollect as directed by the site health and safety officer.

4. If time allows, change out the pump and restart sampling. Turn the sampling pump back on and calibrate as required (Section 5.1) until desired sample volume requirements are met.

5.5 Equipment Decontamination

Non-disposable air sampling equipment will be decontaminated according to instructions provided in the governing document. In general, sampling pumps and tubing will be wet-wiped prior to and following sample collection.

5.6 Sample Custody

Custody requirements for stationary air samples will be specified in the governing document.

6.0 Documentation

In addition to FSDSs, a field logbook will be maintained by each field team member collecting stationary air samples, as prescribed in the governing document.

7.0 Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) for activities described in this SOP will be attained through a variety of processes, including, but not limited to, the items discussed below. Additional QA/QC requirements, such as audits or field assessments, will be addressed in the governing document.

7.1 Training

Every effort will be made to ensure consistency in collecting stationary air samples in support of Libby response actions. Consistency will be achieved to the extent possible through proper training, using designated field staff, and providing FTL oversight. Any deficiencies or inconsistencies in implementing this project-specific SOP noted by the FTL will require re-training of the field team.

7.2 Equipment Maintenance

The manufacturer's instructions regarding operating procedures and maintenance will be reviewed prior to equipment use. Equipment and instrumentation will be utilized in accordance with manufactures instructions.

7.3 Field Quality Control Samples

The field quality control (QC) samples for response action stationary air sampling at the site typically consist of lot blanks and field blanks; however, the field team is referred to the governing document for field quality control sample collection requirements.

8.0 References

CDM. 2011. Response Action Sampling and Analysis Plan, Libby Asbestos Project, Libby, Montana. June.

EPA. 1994. Asbestos Sampling, Standard Operating Procedure #2015, Revision 0.0. November 17.

International Organization of Standardization. 1995. Ambient Air – Determination of Asbestos Fibers – Direct Transfer Transmission Electron Microscopy Method. ISO 10312:1995(E).

Attachment 1

Libby Asbestos Project
Precision Rotameter Calibration Data Sheet

Task Order: _____
Calibration Date: _____ **Calibrated By:** _____
Odometer ID: _____ **Primary Standard ID:** _____
Actual Temp (°F): _____ **Actual Pressure (in. Hg):** _____

°F=Degrees Fahrenheit
in. Hg= inches mercury

	Ball Reading =Y (mid-ball)	Flow rate = X_1 (L/min)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Rotameter Calibration Procedure.

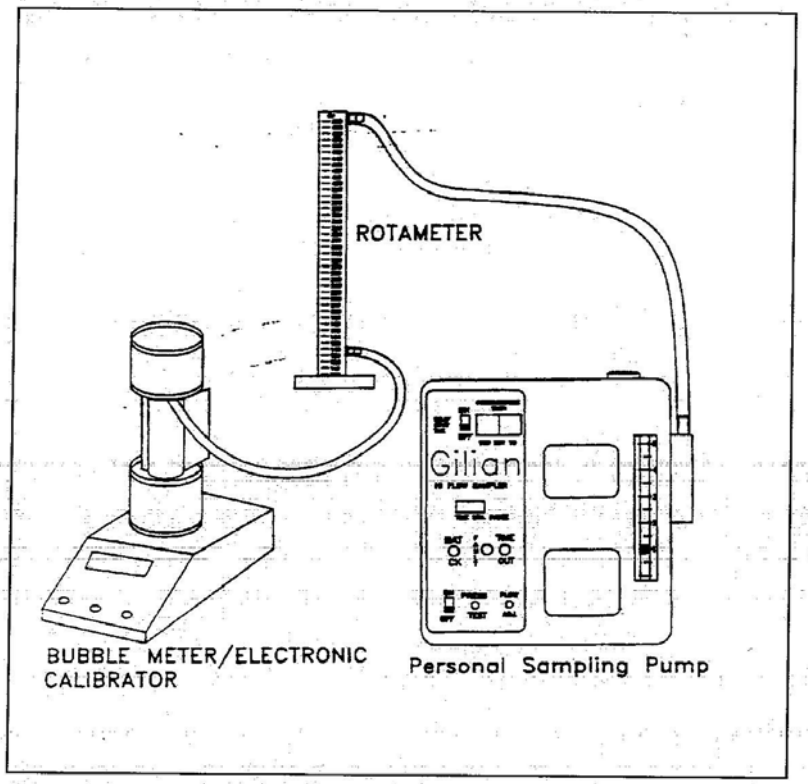
1. Obtain the actual temperature and actual pressure in Libby, MT from the project weather station. Record the actual temp. and actual pressure in the fields provided above.
2. Calibrated rotameter to desired ball reading with a sampling pump and cassette in-line. Cassette must be the same type and from the same lot of cassette that will be used for sampling. Record value in the Ball Reading column.
3. Check adjusted flowrate of sample pump to the Dry Cal flow calibrator primary flow standard. 10 repetitive flow measurements will be averaged and that result recorded in the Flow rate column for the selected interval.
4. Repeat this process at 10 intervals over the range of the precision rotameter.
   Input data into rotameter calculation sheet to generate the corrected flow rate

Attachment 2

APPENDIX B (Cont'd)

Figures

FIGURE 4. Calibrating a Rotameter with a Bubble Meter



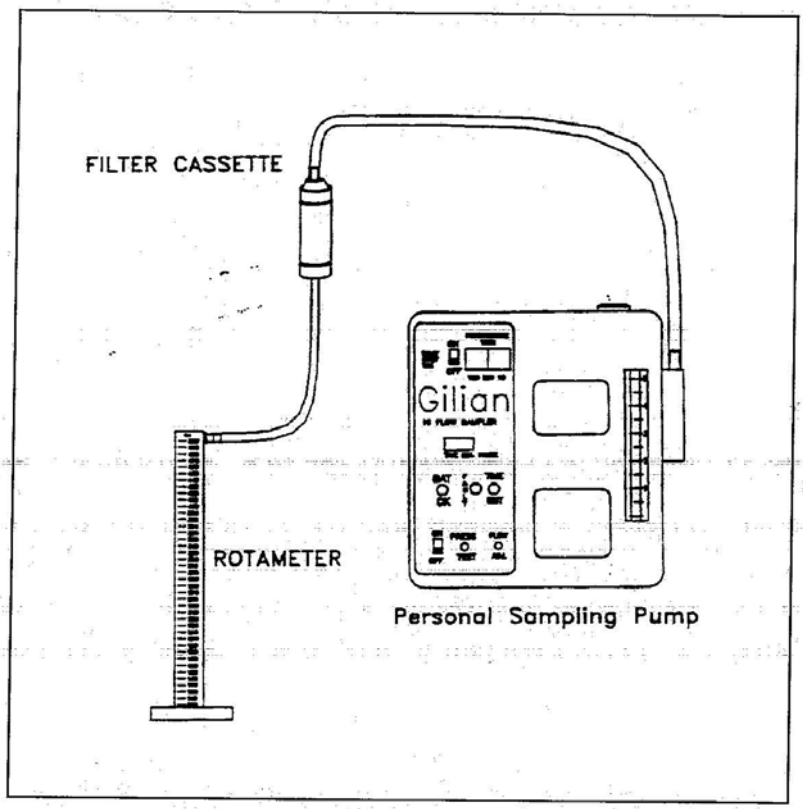
16

Attachment 3

APPENDIX B (Cont'd)

Figures

FIGURE 5. Calibrating a Sampling Pump with a Rotameter



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Libby Asbestos Project
Project-specific Standard Operating Procedure
Semi-Quantitative Visual Estimation of Vermiculite in Soils during Removal Activities

Prepared by: _____ Date: 2/11/13
CDM Smith

Reviewed by: _____ Date: 2/11/13
CDM Smith Technical Reviewer

Reviewed by: _____ Date: 2/11/13
CDM Smith Quality Assurance Reviewer

Revision No.	Date	Reason for Revision
0	6/30/11	--
1	2/11/13	• Administrative updates • Clarify the definition of visible vermiculite

1.0 Purpose

During response actions at contaminated properties, it is EPA's goal to perform as thorough, consistent, and complete a clean up as possible within the criteria established in the governing documents for the Libby Superfund Site. The purpose of this standard operating procedure (SOP) is to provide guidance to project personnel to properly inspect and identify vermiculite on a property in areas where removal activities (i.e., excavation) are not planned.

2.0 Definitions

The following land use designations are used for determining inspection protocol during the investigation phase (e.g., General Property Investigation [GPI]) and will be referenced when conducting the supplemental vermiculite inspections during removal actions.

Specific Use Area (SUA) – Discrete exterior parcels on a property with a designated specific use. Due to the nature of activities typically carried out in SUAs, residents may be especially vulnerable to exposures when Libby amphibole asbestos (LA) contaminated soil becomes airborne. SUAs may be bare or covered with varying amounts of vegetation. SUAs include but are not limited to areas such as:

- Flower Pots
- Flowerbeds
- Gardens
- Stockpiles
- Play Areas
- Dog Pens
- Horse Corrals
- Driveways (non-paved)
- Parking Lots (non-paved)
- Roads (non-paved)
- Alleys (non-paved)

Common Use Area (CUA) – Exterior parcels on a property with varied or generic use. CUAs may be bare or covered with varying amounts of vegetation. CUAs include:

- Walkways
- Yards (front, back, side, etc.)
- Former Gardens
- Former Flowerbeds

Limited Use Area (LUA) – Exterior parcels on a property that are accessed, utilized, and maintained on a very limited basis. LUAs may be bare or covered with varying amounts of vegetation. LUAs include:

- Pastures
- Maintained/Mowed Fields
- Underneath porches/decks[1]
- Overgrown Areas (with trails/footpaths, or between SUAs/CUAs)

Non-Use Area (NUA) – Exterior parcels on a property with no current use (e.g., areas that are not maintained or accessed). NUAs may be bare or covered with varying amounts of vegetation. NUAs include:

- Wooded Lots
- Un-maintained Fields

Point Inspection – Used in SUAs and CUAs. A point inspection (PI) is an intrusive visual inspection of the top portions of the soil at a randomly selected point within a

[1] The soils underneath porches and decks will be classified as LUAs depending on ground clearance and accessibility to homeowners and pets. If these areas are not accessible, they will be classified as NUAs.

zone. A PI consists of the active displacement of the surface material (e.g., soil, gravel, etc.) with a small shovel or trowel and visual inspection of the displaced material to determine if vermiculite is present. If vermiculite is observed during the PI, the location and a semi-quantitative estimate of vermiculite contamination will be recorded as directed in the governing document.

Visible Vermiculite - Exfoliated and/or unexfoliated vermiculite, amphibole asbestiform minerals, and mine tailings present in investigated media (i.e. soil, driveways, parking areas, and alleyways) as part of response actions – herein collectively referred to as visible vermiculite (VV).

Zone – A discrete area on the property delineated by the field staff where PIs will occur. The governing document will describe the location and size of each zone based on the investigation data quality objectives. It should be noted that inspection zones will be established based on site features and removal design (i.e., excavation lines) and may not result in "perfect squares." No area type may be combined with any other area type. For example, driveways and flowerbeds are both SUAs but will be separated into unique zones for visual inspection. Similarly, large CUAs such as yards may be subdivided into multiple zones dependent on site conditions. Sectioning properties into additional zones will be at the discretion of the field teams but consistent among the teams.

3.0 Applicability

This SOP applies to properties within the Libby Superfund Site at varying stages of the removal process. The VV inspection should be performed as early as possible in the removal process to facilitate removal activity planning but will occur before excavation crews leave the area of interest on a property (e.g., back yard, etc.). That is, VV inspections should be performed to coincide with the removal contractor's excavation plan and conducted in areas where the contractor will excavate first and advance to subsequent areas. Timely inspections are imperative so as to minimize moving removal equipment (e.g., excavators, skid-steers, etc.) across excavated areas.

4.0 Procedure

The following sections outline the general process of performing the VV inspections:

- Identify areas of interest
- Establish zones
- Perform PI

4.1 Identify Areas of Interest

Upon arrival at the property, the field staff will locate all areas requiring the visual inspection as required by the governing document. All property use areas should already be categorized (e.g., SUA, CUA, etc.) during previous investigations (e.g., GPI).

If not, categorize land use areas by the definitions provided in Section 2.0. If at any time there are disagreements in identification of inspection areas, the team leaders and/or appropriate government representatives will be consulted.

4.2 Establish Zones

Zones will be established throughout the property within the areas of interest. Inspection zones will only be established in CUAs and SUAs as these are the areas where additional excavation during removal activities will occur. Zones will be used to methodically inspect areas of interest as defined in the governing document. Since the data quality objectives of specific investigations vary, zone inspection area requirements will be discussed in the governing document. The field team will use appropriate measuring tools (e.g., measuring wheel, design drawings, etc.) to establish zone boundaries.

4.3 Perform Point Inspection

Once zones are established, PIs will commence. The number of PIs to be performed in each zone will be detailed in the guidance document. The location of the PIs will be at the discretion of the field team but will be randomly selected within the zone. The following process outlines the general sequence of performing a PI:

- Select an area within the zone.
- Visually inspect the PI location using a spade or trowel, carefully removing excess debris (e.g., organic material, grass, etc.) prior to extraction. Extract an amount of material (i.e., soil, crushed rock, etc.) from the depths as outlined below:
  - CUAs – 0 to 3 inches below ground surface (BGS) or to refusal
  - SUAs – 0 to 6 inches BGS or to refusal
- Visually inspect material and record semi-quantitative estimation of VV as described below.
- Replace cover material.
- Repeat as necessary employing procedure outlined in the governing document.

During PIs, field staff will estimate the quantity of VV observed. Each PI will be assigned a semi-quantitative estimate of VV content using a 4-point scale: none (N), low (L), intermediate (M), and high (H). For PI locations where VV is observed, estimates (e.g., L, M, or H) will be recorded as described in the governing document.

5.0 Health & Safety/Engineering Controls

All personnel will carry out visual inspections in accord with proper personal protective equipment (PPE) and other requirements as outlined in the governing document. If necessary, the field team should use appropriate engineering controls, such as wetting methods, during the PIs to minimize dust generation.

6.0 Equipment Decontamination

Equipment decontamination is not required between PIs as sample collection is not included as part of this SOP. However, field staff should inspect field tools (e.g., shovel, trowel, etc.) between each PI to ensure remnant VV flakes are not remaining. Equipment should be thoroughly decontaminated, using methods outlined in the governing document, before leaving the site.

7.0 Documentation

Appropriate documentation will be recorded for findings of the VV inspection per project requirements. This may include logbooks, QARs, drawing edits, etc. The governing document will describe applicable documentation procedures required for inspection activities outlined in this SOP.

8.0 Training

Every effort will be made to ensure consistency in the semi-quantitative evaluation of VV in soil to the extent possible. This will include training (e.g., field calibration), use of specimen examples (i.e., jars/photographs of low, intermediate, and high quantities of VV, etc.), designated field staff, and oversight by project management staff. Figures illustrating none, low, intermediate, and high quantities of VV are attached to this SOP for reference (Attachment 1).

Attachment 1
Vermiculite Inspection Standards

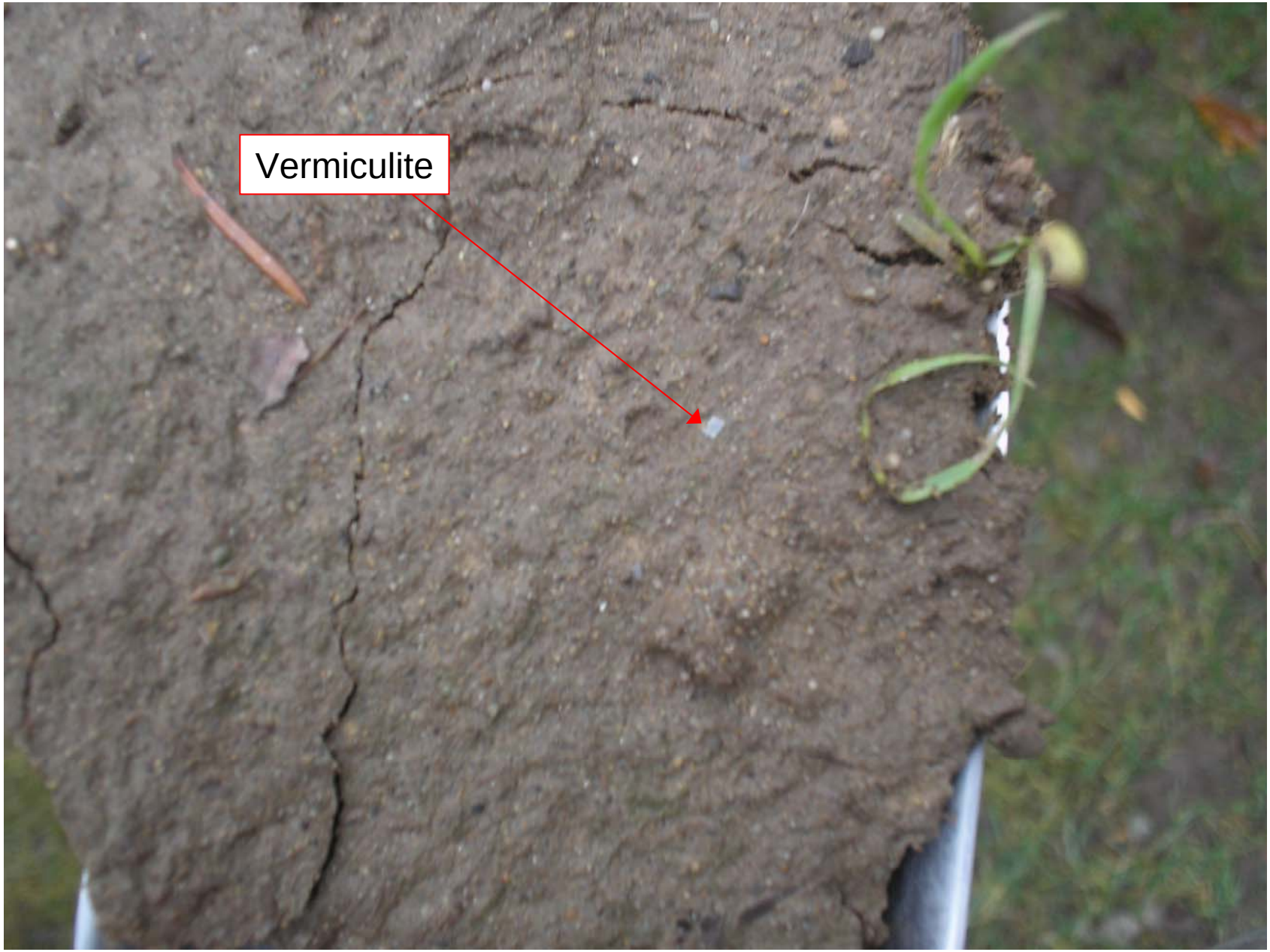

Figure 1: Low Visible Vermiculite – A maximum of a few flakes of vermiculite observed within a given visual inspection point

Figure 2: Intermediate Visible Vermiculite – Vermiculite easily observed throughout visual inspection point, including the surface.

Figure 3: Intermediate Visible Vermiculite – Vermiculite easily observed throughout visual inspection point, including the surface.

Figure 4: High Visible Vermiculite – Visual inspection point contains Approximately 50% (or greater) vermiculite by volume

Appendix B

Air Monitoring Frequencies

Air Monitoring Frequencies

The following table shows 2013 frequencies for project task-based air monitoring performed by the TPIC. Frequencies may be added, adjusted, or removed upon consultation and approval by EPA when project tasks or responsibilities change.

2013 Air Monitoring Frequencies			
		PCM	***AHERA***
Mine Road			
Clean Room			1/Two Weeks
Personal	Water/Truck Driver	1/Two Weeks	-
	Operator	1/Two Weeks	-
	Laborer	1/Two Weeks	-
Investigation and CQC Activities			
Ambient (CDM, PRI, ER Offices)*			1/Month
Ambient (Sample Analysis Lab On-site Analytical Laboratory)*			1/Month
Ambient (EPA Information Center)*		-	1/6 Months
Ambient (Libby Volunteer Fire Department Building)*		-	1/6 Months
Design Inspection (Attic Entries)		1/6 Months	-
Design Inspection (Soil Sampling)		1/6 Months	-
CQC Oversight (Attic Inspections)		1/6 Months	-
Confirmation Soil Sampling		1/6 Months	-
Clearance Air Sampling		1/6 Months	-
Community Involvement Coordination Pre-inspection		1/6 Months	-
Landfill Asbestos Cell			
Personal	Laborer	Daily	
	Operator	Daily	
	Roll off Truck driver	Daily	
Clean Room			1/Event or Week
Perimeter of Exclusion Zones			1/Month
Bulk Removal Sites (Per Contractor)			
Personal	Bulk Removal	1/Week	-
	Demolition	Daily	-
	Detailing Attic	1/6 Months	-
	Wet Wipe/HEPA Vac Living Space	1/6 Months	-
Clean Room		-	1/Site
Excavation Sites			
Personal	Exterior Demo Laborer	1/Two Weeks	
	Exterior Demo Operator	1/Two Weeks	
	Laborer	1/Two Weeks	-
	Excavator Operator	1/Two Weeks	-
	Haul Truck Drivers(Level D PPE)	1/Two Weeks	-
	Support Personnel	1/6 Months	-
Clean Room		-	1/Site
Perimeter of Exclusion Zones		-	1/Site/Day
Perimeter of Exterior Demo Exclusion Zones		-	4/Site/Day

* indicates monitoring to be conducted under the EPA Response Action Contract
PCM = Phase contrast microscopy, Method NIOSH 7400
AHERA = Asbestos Hazard Emergency Response Act, TEM performed by Method EPA 40 CFR Part 763 Final Rule
PPE = personal protective equipment HEPA= high-efficiency particulate air

Appendix C

Sampling and Analysis Plan Analytical Summary Sheet

SAP ANALYTICAL SUMMARY # __LIBRA0611__
SUMMARY OF PREPARATION AND ANALYTICAL REQUIREMENTS FOR ASBESTOS

Title: Response Action Sampling and Analysis Plan (RA SAP), Revision 2, Libby Asbestos Site

SAP Date (Revision): June 2011 (Revision 2)

EPA Technical Advisor: David Berry (303-312-6358, Berry.David@epamail.epa.gov)
(contact to advise on DQOs of SAP related to preparation/analytical requirements)

Sampling Program Overview: The RA SAP supports the collection and analysis of soil and air samples to ensure LA-contaminated media is sufficiently removed to meet the cleanup requirements set forth in EPA's December 15, 2003 Residential/Commercial Cleanup Action Level and Clearance Criteria Technical Memorandum. A limited number of water samples may also be collected from a variety of sources (e.g., domestic supplies such as wells or taps, water supplies used for response actions) to support removal decision-making.

Sample ID Prefix: 3R-

Laboratory Quality Control Sample Frequencies:

TEM: Lab Blank – 4%
Recount Same – 1%
Recount Different – 3%
Verified Analysis – 1%
Repreparation – 1%

PLM: Lab Duplicates – 10%

Requirements Revision:

Revision #:	Effective Date:	Revision Description
0	4/07/10	N/A
1	8/26/10	Water samples, Media Type G, were added to the document.
2	6/30/11	General update making the document consistent with the updated Response Action Work Plan (PRI 2011).

PLM Preparation and Analytical Requirements:

Medium Code	Sample Type	Preparation Method	Analysis Method	Applicable Laboratory Modifications
A	Soil	PLM-9002; representative sample aliquot may additionally be oven dried as needed	PLM-9002	None

Medium-Specific TEM/PCM Preparation and Analytical Requirements for Field Samples:

(a) See LB-000053 for additional details (b) See most current version of EPA-LIBBY-08 for preparation details

*If any one clearance air sample in a set is overloaded, the laboratory will immediately notify the EPA Laboratory Coordinator for instruction on how to proceed.

Medium Code	Medium, Sample Type	Preparation Details				Analysis Details			Applicable Laboratory Modifications
		Investi-gative? (a)	Indirect Prep? (a,b)		Filter Archive ? (b)	Method(s)	Recording Rules	Analytical Sensitivity/ Prioritized Stopping Rules	
			With Ashing (b)	Without Ashing (b)					
B	Stationary Air (Clearance)	No	No*	No*	Yes	TEM–AHERA	All Asbestos; L: ≥ 0.5µm AR: ≥ 5:1	Count until one is achieved: i) Target S = 0.005 s/cc, or ii) Evaluate a minimum filter area of 0.1 mm^2, or iii) 50 LA structures are enumerated (finish GO where 50th LA found) **Chrysotile only**: 50 chrysotile (finish GO where 50th chrysotile found)	Current versions of: LB-000019, LB-000028, LB-000029, LB-000030, LB-000031, LB-000067, LB-000084, LB-000085
C	Stationary Air (Ambient/ Perimeter)	No	No	Yes, if material is overloaded (>25%) or unevenly loaded on filter	Yes	TEM–AHERA	All Asbestos; L: ≥ 0.5µm AR: ≥ 5:1	Count until one is achieved: i) Target S = 0.005 s/cc, or ii) Evaluate a minimum filter area of 0.1 mm^2, or iii) 50 LA structures are enumerated (finish GO where 50th LA found) **Chrysotile only**: 50 chrysotile (finish GO where 50th chrysotile found)	Current versions of: LB-000019, LB-000028, LB-000029, LB-000030, LB-000031, LB-000067, LB-000084, LB-000085
D	Health and Safety Personal Air	No	No	Yes, if material is overloaded (>25%) or unevenly loaded on filter	Yes	PCM – NIOSH 7400, Issue 2 TEM–AHERA (upon request)	For PCM: NIOSH 7400, "A" rules If AHERA is requested: All fibers L ≥ 0.5 µm AR ≥ 5:1	For PCM: Count until 100 fibers are detected. Count a minimum of 20 FOVs. Stop at 100 FOVs regardless of count. For AHERA: Evaluate a minimum filter area of 0.1 mm^2	For PCM: LB-000015 For AHERA: Current versions of: LB-000019, LB-000028, LB-000029, LB-000030, LB-000031, LB-000067, LB-000084, LB-000085

Medium Code	Medium, Sample Type	Preparation Details				Analysis Details			Applicable Laboratory Modifications
		Investi-gative? (a)	Indirect Prep? (a,b)		Filter Archive ? (b)	Method(s)	Recording Rules	Analytical Sensitivity/ Prioritized Stopping Rules	
			With Ashing (b)	Without Ashing (b)					
G	Water	No	No	No	Yes	EPA 100.2	All asbestos L ≥ 0.5 µm AR ≥ 3:1	Count until one is achieved: i) Target S = 0.2MFL ii) An area of 0.5 mm^2 of filter area evaluated	Current versions of: LB-000019, LB-000020, LB-00020a, LB-000028, LB-000029, LB-000030, LB-000031, LB-000067, LB-000084, LB-000085

TEM/PCM Preparation and Analytical Requirements for Field Quality Control Samples:

Medium Code	Sample Type	Preparation Details			Analysis Details			Applicable Laboratory Modifications
		Indirect Prep?		Archive?	Method	Recording Rules	Stopping Rules	
		With Ashing	Without Ashing					
E	Lot Blank	No	No	Yes	PCM – NIOSH 7400, Issue 2 TEM – AHERA	For PCM: NIOSH 7400, "A" rules For AHERA: All Asbestos; L: ≥ 0.5µm AR: ≥ 5:1	For PCM: Count until 100 fibers are detected. Count a minimum of 20 FOVs. Stop at 100 FOVs regardless of count. For AHERA: Evaluate a minimum filter area of 0.1 mm^2	For PCM: LB-000015 For AHERA: Current versions of: LB-000019, LB-000028, LB-000029, LB-000030, LB-000031, LB-000067, LB-000084, LB-000085
F	Field Blank	No	No	Yes	PCM – NIOSH 7400, Issue 2 TEM – AHERA	For PCM: NIOSH 7400, "A" rules For AHERA: All Asbestos; L: ≥ 0.5µm AR: ≥ 5:1	For PCM: Count until 100 fibers are detected. Count a minimum of 20 FOVs. Stop at 100 FOVs regardless of count. For AHERA: Evaluate a minimum filter area of 0.1 mm^2	For PCM: LB-000015 For AHERA: Current versions of: LB-000019, LB-000028, LB-000029, LB-000030, LB-000031, LB-000067, LB-000084, LB-000085

Analytical Laboratory Review Sign-off:

All laboratories signed the original version of this analytical summary sheet (Rev0); this revision (Revision 2) did not require another signature process.

Appendix D

Municipal Alleyways, Driveways, and Parking Areas Decision Chart

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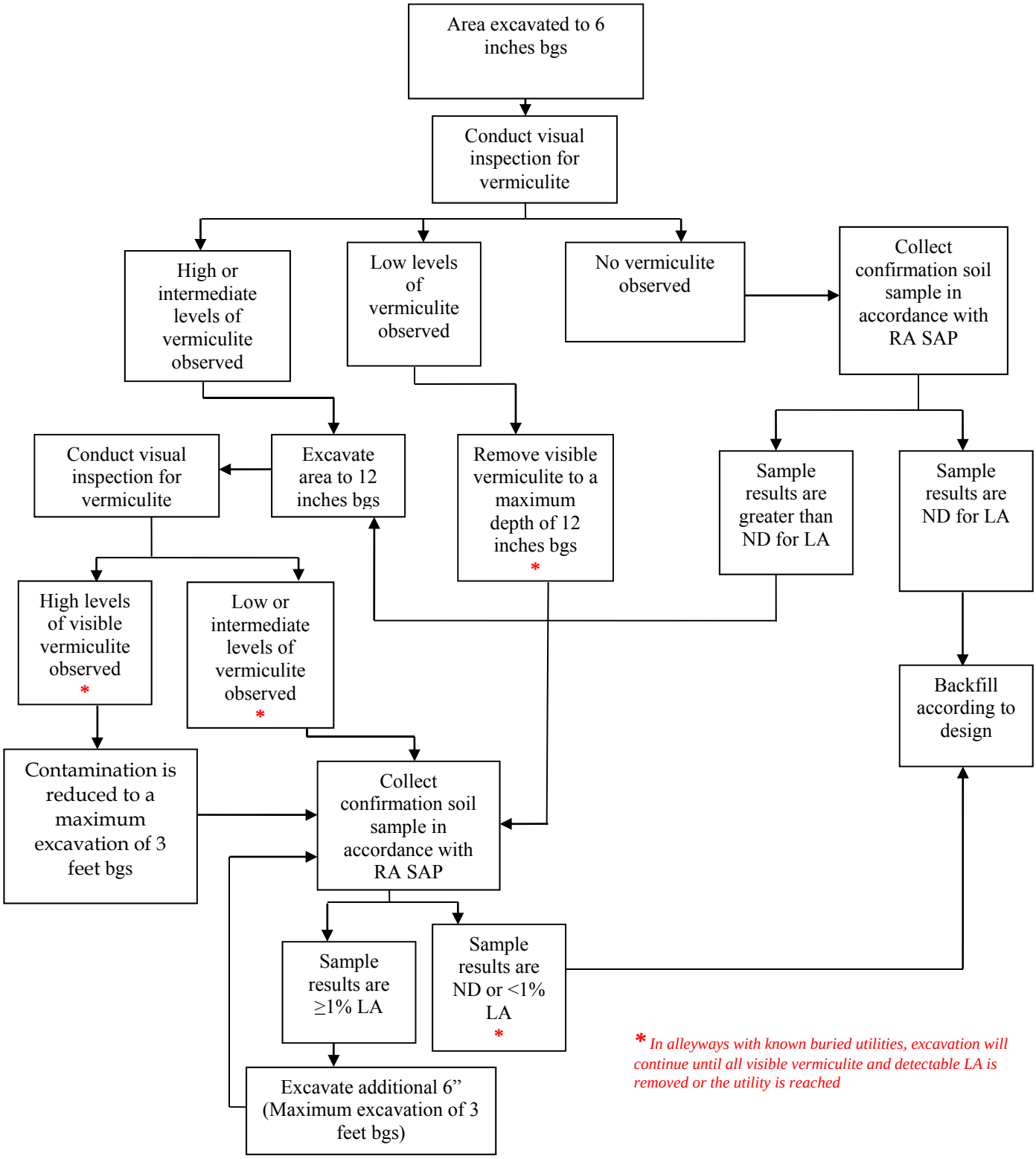
Municipal Alleyways, Driveways, and Parking Areas Decision Chart



* *In alleyways with known buried utilities, excavation will continue until all visible vermiculite and detectable LA is removed or the utility is reached*

Appendix E

Residential/Commercial Alleyways, Driveways, and Parking Areas Decision Chart

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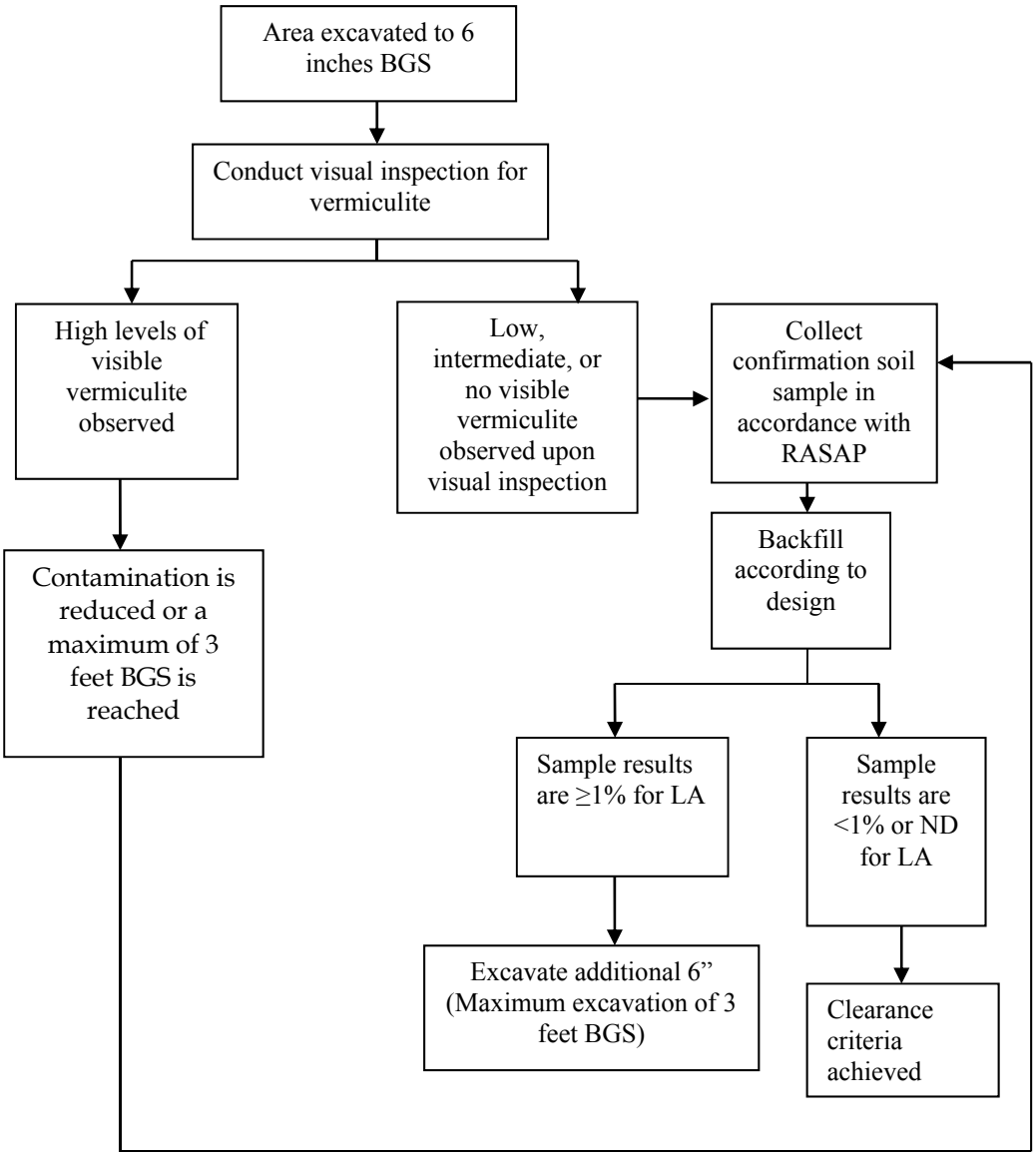
Residential/Commercial Alleyways, Driveways, and Parking Areas Decision Chart



Record of Modification to Documents Governing Field Activities Libby Asbestos Project

Form No. LFO-000181

Instructions: Complete form and obtain necessary approval(s). File approved copy in the project file and post final version to the Libby Field eRoom.

Requester: Dominic Pisciotta
Company: CDM Smith

Title: Environmental Scientist
Date: 9/17/13

Governing document (title and approved date) or SOP (title and SOP number): **Response Action Sampling and Analysis Plan, Libby Asbestos Superfund Site, Libby, Montana, Revision 3, April 2013**

Field logbook and page number where modification is documented (or attach associated correspondence):
NA

Description of modification (attach additional sheets if necessary; include revised text for all document or SOP sections that are affected by the modification): The following modifications are intended for those response actions taking place within Operable Unit (OU) 7 (Troy) and shall not be followed for response actions occurring in any other OU. **Section 3.1.5 Step 5-Develop Decision Rules (Table 3-3):** Vermiculite visible in the sidewalls of the excavation at intermediate and high levels will be excavated at 12-inch increments linear to the excavation until vermiculite visible reaches low levels, no vermiculite is visible, or the property boundary is reached. Sidewalls where low levels of vermiculite are visible will be lined with polyethylene sheeting and indicated on the draft as-built drawing by third-party quality assurance (TQA) personnel. **Section 3.1.5 Step 5-Develop Decision Rules (Table 3-3):** Vermiculite visible in surface soils adjacent to the excavation boundary, or in newly identified property areas, will be excavated if intermediate or high levels are present. Low levels of vermiculite shall only be removed up to three feet beyond the planned excavation to accommodate for variations in the design drawing cutline and actual field conditions and shall not extend beyond three feet past the planned excavation. **Section 4.6.2 Visible Vermiculite Point Inspection Methods:** Results of Point Inspections (PIs) will be recorded on a separate black and while copy of the removal plan and marked "vermiculite visible in surface soils not excavated" by TQA personnel. The following Decision rules for performing vermiculite point inspections listed on pages 4-14 and 4-15 will only be in effect for those areas where low levels of vermiculite are removed to accommodate for variations in the design drawing cutline and actual field conditions (i.e., three feet beyond planned excavation) during response actions within OU7:

- Zones where one "low" observation (i.e., one flake) of vermiculite is recorded will be re-inspected by five additional follow up PIs. If vermiculite is not observed during the follow up PIs, the zone will not be excavated. If one "low" observation of vermiculite is recorded during the follow up PIs, perform five final PIs. If two or more flakes of vermiculite are recorded during follow up PIs, the area will be excavated. If during the final five PIs any vermiculite is observed, the area will be excavated. If vermiculite is not observed during the final five PIs, the zone will not be excavated.

- Zones where two or more "low" observations (i.e., two or more flakes) of vermiculite will be excavated

Implication(s) of modification (if applicable, attach a list of affected property addresses or sample IDs): As noted above, due to the differences in removal criteria between OUs on the Libby Asbestos Superfund Site,

the changes above will only be effective for OU7 (Troy) removal properties. There are no anticipated negative implications of this modification.

Duration of modification (indicate one):

Temporary Date(s):_____

Permanent Effective Date: September 13, 2013

Data Quality Indicator (indicate one; reference the definitions below for direction on selecting data quality indicators):

❑ Not Applicable	❑ Low Bias	❑ High Bias
❑ Reject	❑ Estimate	☒ No Bias

Prepared by: _____ Date: 9/17/13

Print Name: Dominic Pisciotta
(Team Leader or designate)

Reviewed by: _____ Date: 9/24/13

Print Name: Jeremy Ayala
(USACE Project Manager or designate)

Approved by: _____ Date: 10/1/13

Print Name: Mike Cirian

(EPA RPM or designate)

DATA QUALITY INDICATOR DEFINITIONS

Reject - Samples associated with this modification form are not useable. The conditions outlined in the modification form adversely affect the associated sample to such a degree that the data are not reliable.

Low Bias - Samples associated with this modification form are useable, but results are likely to be biased low. The conditions outlined in the modification form suggest that associated sample data are reliable, but estimated low.

Estimate - Samples associated with this modification form are useable, but results should be considered approximations. The conditions outlined in the modification form suggest that associated sample data are reliable, but estimates.

High Bias - Samples associated with this modification form are useable, but results are likely to be biased high. The conditions outlined in the modification form suggest that associated sample data are reliable, but estimated high.

No Bias - Samples associated with this modification form are useable as reported. The conditions outlined in the modification form suggest that associated sample data are reliable as reported.